UNITED STATES DEPARTMENT OF AGRICULTURE
CIRCULAR No. 124

Washington, D. C. October, 1930

RATE OF GROWTH OF SECOND-GROWTH SOUTHERN PINES IN FULL STANDS

By R. D. FORBES
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and
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CONTENTS

THE ECONOMIC IMPORTANCE OF SECOND-GROWTH SOUTHERN PINE

As a group the four chief southern pines rank among the most rapidly growing commercial trees of the United States. Up to about 25 years of age two of them, loblolly and slash, are exceeded in production of cordwood by only one American softwood. On average soils full stands of second-growth longleaf pine produce in 20 years 15 cords of pulpwood to the acre, from trees 4 inches in diameter and up; shortleaf pine in the same time, 18 cords; loblolly pine, 28 cords; and slash pine, 36 cords. Because of rapid growth and, for second-growth, relatively clean stems these species begin to

[1] Funds for beginning the study of growth of the southern pines, which has furnished the main body of information presented in this circular, were supplied by the Southern Pine Association of New Orleans, La., to the National Research Council. Plans for this study were outlined by Raphael Zon, of the National Research Council and the Forest Service. Cooperation in the field work was received from the following State foresters: Chapin Jones, conservation and development commission, Virginia; J. S. Holmes, department of conservation and development, North Carolina; V. H. Sonderegger, department of conservation, Louisiana; and E. O. Siecke, forest service, Texas. The bulk of the field work was, however, done by the Southern Forest Experiment Station. The computations of the resulting volume, yield, and stand tables were done under the direction of Donald Bruce. Special acknowledgement for services rendered in connection with the growth study is due the following: R. M. Brown, Austin Cary, W. R. Hine, and L. H. Reineke. The hearty cooperation of a large number of individuals and organizations, widely scattered throughout the South and elsewhere, has alone made possible the publication of this circular.

[2] Mr. Forbes's work on this project began with his cooperation in the earlier field work, as superintendent of forestry in the Louisiana Department of Conservation. Mr. Forbes was appointed director of the Allegheny Forest Experiment Station in 1927.

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mature saw logs of merchantable grades in substantial quantities at a very early age, as low as 25 years for loblolly and slash pines. At 40 years a well-stocked acre of longleaf will cut 11,600 board feet, by the International rule, from trees 7 inches in diameter and up; shortleaf, 17,800 feet; slash, 22,650 feet; and loblolly, 29,900 feet. Posts, crossties, piling, poles, and other products are produced in corresponding quantities at intermediate ages. Longleaf pine on average soils is ready for profitable turpentining at 25 years and slash pine at 20 years.

Remarkable as are many of these figures in comparison with the average rate of growth of timber in the United States, they are even more impressive when considered in connection with the swift rise in stumpage values of southern pines, and the enormous acreages available for their growth.

In few sections of the United States, if in any, have stumpage rates of softwoods as a group advanced more rapidly in the past quarter century than in the lower Mississippi Basin, which includes Alabama, Mississippi, Louisiana, Arkansas, and Texas. From 85 cents a thousand feet in 1900, or only 46 per cent of the average price of softwood stumpage in the United States, the average stumpage value of softwoods in these States had risen by 1924 to $7.15, or 137 per cent of the average for the Nation. The average value of stumpage in the South Atlantic States, which include the remainder of the southern pine belt, was in 1900 only 43 per cent of the national average, but by 1924 had equaled it. These figures include both pine and cypress, but the pine figures follow the average closely. North Carolina pine (chiefly loblolly) is now overwhelmingly second growth, and its rise in value is therefore an excellent indication of the steady upward trend of second-growth pine stumpage of all species. Beginning at 90 cents a thousand feet in 1900, this stumpage doubled in value within 5 years, doubled its new value in 10 years more, and between 1915 and 1924 increased from $3.60 to $5.80.

Rapid in growth and constantly increasing in value, the southern pines are at the same time the chief trees of a forest area but 4 per cent smaller (*14* [3]) than the entire forest area of the western United States. (Fig. 1.) A trifle less than 1 out of every 4 acres of forest land in the Nation is southern pineland. The southern "piney woods" are not even approached in size by any other forest association within the national boundaries. It is estimated that when the United States undertakes to grow timber systematically, nearly a quarter of the wood produced will come from southern pineland, and probably all of the naval stores.

Partly because of the very wide distribution of the southern pines no regional studies have previously been made either of their volume as individual trees or of their growth in forest stands. A few excellent and in some instances very detailed studies have been made in a single State, and less thorough-going studies of single species in the region as a whole. The results of these studies have been published under titles listed on page 76. But the comprehensive figures to be presented here were collected in the first region-wide

[3] Italic numbers in parentheses refer to Literature Cited, p. 76. Table 10 of the publication here quoted divides the region dominated by southern pine into two "timber types"—oak-pine and southern pine proper. As a practical matter it is nearly impossible to maintain this distinction, and this bulletin adheres to the commoner practice of considering both types as southern pineland.

study of all four of the important species, covering important forest areas in Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, and Arkansas. Their presentation, together with an explanation of how they may be useful to owners of southern pineland, is the chief object of this bulletin.

Definite information on the often astonishing rate at which under favorable circumstances second growth produces cordwood and saw logs can not fail to encourage southern landowners to grow these pines. But it is equally important to point out that the growing of southern pines is a matter of interest to many persons besides the individual landowner. Second-growth southern pine can play a leading part in solving the South's great cut-over land problem, in maintaining southern prosperity, and in supplying a national demand for wood and naval stores. The discussion of these possibilities in the following pages will tend to form an illuminating background for the main body of the bulletin.

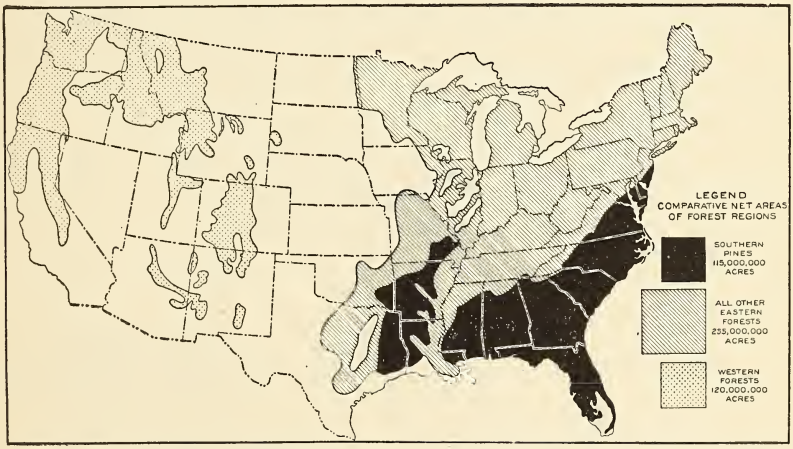

FIGURE 1.—The southern pineries comprise about a third of the forest land in the East and nearly equal in area the forest lands of the West. The outlines on the map indicate gross areas of forest land (that is including land now cleared), but the figures in the legend give the net areas

TIMBER GROWING AND LAND USE IN THE SOUTH

THE CUT-OVER LAND SITUATION

The original southern pine forests of the 12 States from Virginia south to Florida, west to Oklahoma and Texas, and north into Missouri covered about 210,000,000 acres (*10*).

The manufacture of pine lumber began on the Atlantic coast close to the early settlements in Virginia and the Carolinas. It spread southward to Georgia and Florida, and later westward from those States to the western boundary of the pine region. In the extension of the industry westward, the shortleaf forests, which in general occupied the better soils, were the first to be logged, so that the northern portions of Georgia, Alabama, Mississippi, Louisiana, and eastern Texas, together with Missouri and portions of southern Arkansas, were cut in advance of the vast acreages, chiefly longleaf, nearer the coast. Locally, however, the lumber industry early reached the

readily accessible longleaf timber nearest the main streams of the South, such as the Peedee, Santee, Savannah, Chattahoochee, Alabama, Sabine, and Neches Rivers.

In the early days of small-scale logging operations and correspondingly small timber holdings by individual owners, farming generally kept step with logging, shortleaf stump lands going into use as plow or pasture land about as fast as cutting proceeded. But beginning about 1890, the scale of both logging and timber ownership increased until at the present time scores of southern pine operators measure their holdings in tens of thousands and even hundreds of thousands of acres (*19*).

The naval-stores industry, although progressing in much the same fashion southward along the Atlantic coast, and to some extent westward along the Gulf coast, differed from the sawmill industry in being built up not on owned but on leased land. Much of the territory in Georgia, northern Florida, and Alabama, in which the present naval-stores industry, based largely on second-growth longleaf and slash pines, is now centered, has thus been broken up into rather small holdings.

The aftermath of the great southern pine industries has been a cut-over land problem of staggering proportions. In 1927, out of the original vast area of virgin pineland, but 12,650,000 acres remained uncut. (Table 1.) Of this 43 per cent lay in Florida alone.

TABLE 1.—*Areas of unimproved southern pinelands in the chief producing States by character of growth, 1927* [1]

[Areas in thousands of acres; i. e., 000 omitted]

State	Total [2] area	Area of old growth [3]	Area of cut-over [4] lands			
			Total	Fully or partially restocked to saw timber [5]	Fully or partially restocked to saplings and cordwood	Not restocked
Virginia	4,000	----------	4,000	1,950	1,850	200
North Carolina	10,700	250	10,450	5,350	3,900	1,200
South Carolina	8,000	200	7,800	4,150	2,100	1,550
Georgia	15,500	350	15,150	6,200	5,900	3,050
Florida	18,000	5,450	12,550	3,150	4,300	5,100
Alabama	15,500	1,350	14,150	3,900	5,100	5,150
Mississippi	12,000	1,350	10,650	2,950	2,500	5,200
Louisiana	11,750	1,400	10,350	2,150	4,000	4,200
Texas	7,800	1,300	6,500	1,650	1,700	3,150
Arkansas	9,500	650	8,850	2,750	5,250	850
Oklahoma	2,250	350	1,900	250	1,150	500
Total	115,000	12,650	102,350	34,450	37,750	30,150

[1] Table 1 is a computation based chiefly on a survey of standing pine timber made in the main producing region, from Virginia to Texas, in 1924. This was conducted by the Southern Pine Association, New Orleans, and is believed to be the most accurate survey of timber resources yet made in any important lumber-producing region of the United States. The data were obtained in the form of board feet, but have been converted into acreages for the purposes of this bulletin. The computed figures have been checked against the local knowledge of State and Federal forest officers and other authorities.

[2] Exclusive of cleared land and improved pastures formerly in pine.

[3] Virgin timber.

[4] Lands only lightly culled appear under heading of virgin timber.

[5] Includes both true second growth and remnants of the virgin stand now merchantable.

Out of the more than 102,000,000 acres of the piney woods which by 1927 had been cut over without having been converted into farms, 30,000,000 was producing no forest with any promise of merchantable value, the tree growth consisting of a few scattered trees, rem-

nants of the virgin forest, not worth the expense of logging. Some individual trees are growing at a good rate, but they are too few in number to be merchantable. Neither is young growth abundant enough to promise a future stand of commercial value. Perhaps as much as 10,000,000 of the 30,000,000 acres has been stripped so clean of the old-growth seed trees that no amount of fire protection will avail to bring about its natural reforestation within any reasonable period. About 1,330,000 acres of pineland is added annually to these wastes, without seed trees or hope of natural regrowth.

In the face of every handicap, some 34,500,000 acres out of the 102,000,000 cut over supported in 1927 a merchantable stand of true second-growth saw timber or had enough scattered trees left from the virgin growth to be worth logging. One thousand feet, board measure, to the acre is probably the lower limit for a merchantable stand to-day. Much heavier stands were formerly necessary for profitable operation. About 3,600,000 acres of this second-growth saw timber is being cut over or heavily turpentined yearly. The greater part of this acreage is not cut quite so closely as the virgin forests, but future growth of the trees left is menaced by fires in the tops and slash left in logging, and by fire, insects, and rot following chipping.

Intermediate in condition between the devastated lands and those already bearing second-growth or virgin timber "hold overs" in merchantable stand are about 38,000,000 acres which have reforested naturally to young trees now of cordwood size or less. In longleaf and slash pine stands of this character turpentining begins as soon as a few trees have reached sufficient size to hold a cup, and ordinary chipping methods are such as to overtax the trees, regardless of size. Fires are set in the turpentine "orchards" with even greater regularity than elsewhere, and only those trees which are being actively worked receive protective raking. Every year 15,000,000 of what were formerly the most vigorous and promising young trees of the second-growth stands are crippled or killed outright by the combination of turpentining and fire. Although entire stands are not often wiped out by this combination and reduced to idleness overnight, as is the case when land is logged clean, production per acre is so lowered that over large areas the effect is the same. The annual cutting of over 15,000,000 cords of fuel, more than 600,000 cords of pulpwood, and a vast number of posts, staves, small ties and poles, and miscellaneous products, partly from the acreage classed as cordwood and saplings, further reduces the proportion that would otherwise reach saw-log size. Clearing for "new ground" in the piney woods is not important to-day except in a few localities.

TIMBER GROWING AS THE FEASIBLE SOLUTION

What to do with their cut-over lands has long been the anxious concern of most large manufacturers of southern pine. That it has not as often been the query of the small landowners as well—the farmers, who own from one-seventh to two-thirds of the forest land (*13*)[4] in the several States—is due chiefly to the fact that small tracts generally reforest naturally to stands of at least satisfactory density,

[4] Table 1 of this reference gives the area of farm woodlands in Texas as more than 92 per cent of the total forest area. The acreage of farm woodlands, however, includes large areas of mesquite and similar vegetation having only a trifling value for anything but fuel. These were excluded from the estimate, obtained from other sources, of the total area in forest. Even so, the farmers of Texas undoubtedly own more than half of the true forest land in their State.

and return almost automatically to a productive state. Aside from such considerations as the production of game and fish, watershed protection, and the furnishing of recreation to an increasing number of out-of-doors enthusiasts, there are three primary uses for the cut-over lands of the South. These are farming, grazing, and timber growing.

FARMING AS A USE FOR CUT-OVER LANDS

Farming on cut-over pinelands of the better grades is in many localities full of promise, where such special conditions exist as unusual climate (as in the peninsula of Florida) or unusual railroad facilities

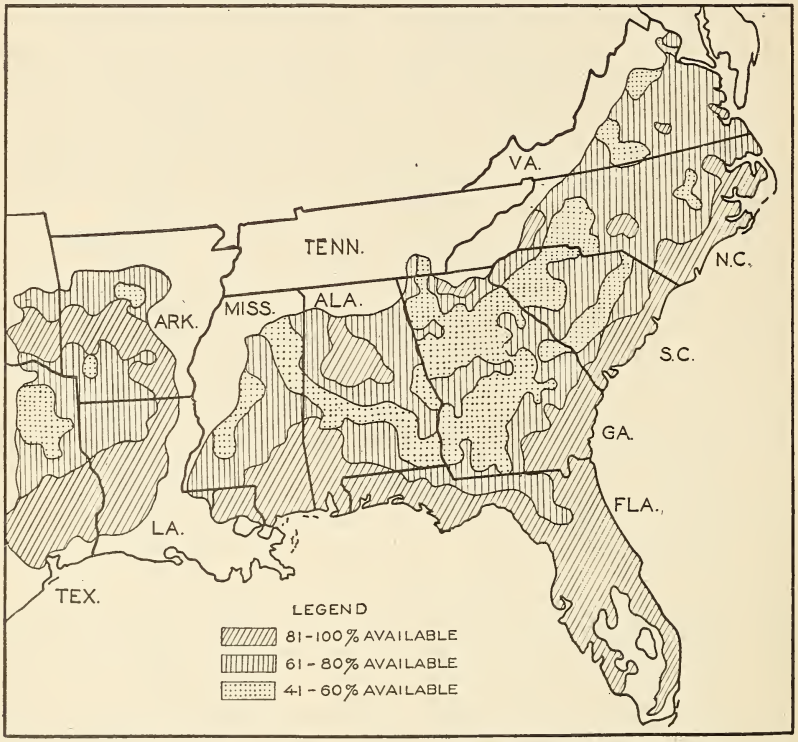

FIGURE 2.—Timber growing does not elbow agriculture in the South. In preparing this map the area of improved farm land in each county in 1920 was subtracted from the total land area of the county; the balance is roughly the area available for growing timber. Since the map is necessarily generalized, it should not be relied upon as a guide to local conditions

(as in the strawberry-growing regions of eastern Louisiana and eastern North Carolina and the truck-growing section of southeastern Virginia). But as a solution of the broad problem of what to do with millions rather than thousands of acres of land, local developments such as these are plainly ineffective. Farms on the poorer pineland already cleared in many parts of the South are being abandoned at a considerable rate. From 1910 to 1925 the total acreage of southern land in farms showed a gain only in Florida and Oklahoma. Within the 10 years from 1910 to 1920 both Virginia and North Carolina experienced a shrinkage in the farm land classified as actually improved. Figure 2 shows the high percentage of land in the piney

woods of the South which, according to the 1920 census, was not improved farm land and is therefore almost in its entirety available for timber growing.

Even should the population of the United States ever reach a point where there will be real need for the clearing of more forests to make way for farm crops, a very substantial percentage of the southern pine region will be found to be of low agricultural value. In 1921 the Bureau of Soils, United States Department of Agriculture (*3*), announced that out of about 95,000,000 acres in the more southerly part of the coastal plain, chiefly pinelands in Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas, 23.3 per cent, or 22,000,000 acres, was in its opinion hopeless from the agricultural standpoint, and an additional 15.4 per cent, or 14,600,000 acres, was likely to prove for the most part very inferior farm land. As for good, unimproved farm land, at least one generation of trees may be grown on the bulk of it before it is needed for cultivation.

GRAZING USE

Grazing on the pinelands of the South, although in times past a profitable industry, has lately fallen upon evil days. In the six States, Georgia, Florida, Alabama, Mississippi, Louisiana, and Arkansas, in which grazing on fenced or unfenced "range," as distinguished from improved pastures, is important, there were at the beginning of 1925, 3,269,000 head of cattle other than dairy cows and heifers, 439,000 sheep, and 4,687,000 hogs (*16*). It is safe to say that over 50 per cent of this grand total of 8,395,000 animals subsist on the range and that more than 50 per cent of the range may be called pineland.

Turned out to graze on a range burned over nearly every year and, as authorities now point out (*7*), constantly deteriorating under such treatment, range livestock have been subject to vicissitudes of all kinds. In spite of the relatively mild climate of the South there has been a loss from exposure comparable to that in many other important stock-producing regions of the United States. Disease and parasites, such as the tick fever in cattle, stomach worms in sheep, and cholera in hogs, have decimated the herds, and lack of fences has greatly increased the difficulties of prompt and thorough control. Yet it seems entirely possible to reorganize the stock industry of the South by such measures as prevention of fires, fencing of the range, production of winter feed, and introduction of scientific feeding and breeding methods. Progress is already being made along all of these lines, but it is probable that the range stock found in the States listed above could be supported on less than one-half of the pine area over which they now roam without recourse to any such intensive method as artificial seeding of the cut-over lands to improved forage plants.

Farming and grazing on the southern pinelands have not been extensive enough to solve the cut-over land problem. Some additional remedy for this condition must be sought. The use for productive farming of but 1 to 20 per cent of the area of many a county and the conduct of a precarious stock-raising industry on its open range have not offset the steady reduction in taxable values brought about by the cutting of the virgin timber. Forced to raise the assessment on what timber still remained, in order to maintain good roads, fine school houses, and similar commendable improvements built while lumber-

ing was at its height, the local authorities have inevitably hastened the day of bankruptcy by compelling the mills to cut their timber as fast as possible. In localities where the virgin timber is all gone and fires and close cutting have prevented a new growth from coming on, the condition of local governments is often pitiable. Taxes are not enough to meet the expense of enforcing laws, maintaining schools, and repairing (much less building) roads. Without security in the form of productive and taxable land, county commissioners and supervisors can not borrow money for current use pending an improvement in local fortunes. Poor schools and impassable roads force the more progressive citizens to move away, thus still further reducing local resources. Many communities in what were formerly the piney woods are to-day in a desperate plight.

TIMBER GROWING

The growing of new crops of trees is the third great use for cut-over lands. It is not a spectacular remedy for the ills arising from the idleness of land, or one which will restore bankrupt communities overnight. But it is a sure one and, as later figures will show, not by any means as slow as many people have imagined.

Timber growing in the South has up to recent years been almost altogether a haphazard affair. The fine young timber which has developed naturally, generally in the face of all sorts of handicaps imposed by man, serves to open the eyes to what might be done under a thoughtful program of timber culture.

The original growth throughout the 115,000,000 acres listed in Table 1 as pineland was pure pine, or a mixed stand of pine and what is now valuable hardwood, and the second-growth forests are either of pure pine or a mixture in which pine predominates. These pine forests of the South are, by and large, probably as easy to reproduce naturally as any timber type in the United States. With the exception of longleaf pine, southern pines bear seed in abundance almost every year. The seed is light and well-winged, so that it blows to astonishing distances on the autumn and winter winds. Apparently a special seed bed is rarely necessary for satisfactory germination, and a high percentage of the seed is normally sound. Provided fires are kept out, there is little native vegetation to interfere seriously with the growth of the young pines in the greater part of their range.

OBSTACLES TO TIMBER GROWING

With every favorable natural condition, timber growing has not been practiced in the South on the scale which might be expected. There have been four main obstacles to its practice. These are frequent fires, methods of taxation which encourage rapid cutting-out of stands, the competition of apparently unlimited supplies of virgin timber, and the unfamiliarity of landowner and public alike with the whole business of timber growing, including the rate of growth of southern species.

FIRES

Forest fires have been the chief stumblingblock to timber growing in the South. Fires wipe out young trees and at the very least reduce the rate of growth of older trees. The earliest attempt in the southern pine region to control forest fires by means of a field organization was

made in North Carolina no earlier than 1915. In that State, as in every other, efforts were necessarily first directed toward convincing the average citizen that fire is a bad thing. Organized, aggressive fire fighting has been undertaken only within the past few years in any southern State. Since North Carolina undertook to control fires, Virginia, Texas, Louisiana, Alabama, Georgia, Oklahoma, Mississippi, Florida, and South Carolina have followed in her footsteps, in the order named. By 1929 only Arkansas still had made no appropriation for combating forest fires. Laws against firing another's woods were on the statute books for years in nearly every Southern State, but in the absence of a well-planned organization and adequate funds with which to administer them they remained a dead letter until recently. All too frequently the substantial lumberman-landowner, who might otherwise have endeavored at least to avoid starting fires himself, has been burned out by his neighbors or by those who grazed livestock at large on his land. The average farmer has felt obliged to protect his fences by burning around them; the turpentine operator has felt obliged to rake around his trees and burn his orchards; and each class of citizens has blamed the others for the necessity for using fire.

TAXATION

Taxation is in some Southern States a really formidable obstacle to the practice of forestry, and in others has been at least a deterrent. Under the constitutions of but few States does it seem possible to classify property for purposes of taxation. Hence land bearing standing timber is generally assessed at precisely the same rate as farm land. Yet the latter produces a yearly crop of corn or cotton from the sale of which taxes may be paid, while the forest land at best takes many years to produce a single crop of wood or gum. This may be remedied on a large scale by amendment of State constitutions and the enactment of laws to tax growing trees only as income is available from them; that is, when they are cut.

Taxes on cut-over pineland at the present time vary between States, and between counties within the States. As long as cut-over land was assessed at from $1 to $5 an acre, and no additional values were placed upon it because a few scattered seed trees were left standing, landowners were not seriously burdened by the payment of taxes, which ranged from 2 to 10 cents an acre a year. But when the counties began to place full value on the lumber left in scattered trees, and when assessments on the land itself were raised beyond possible sale values, a tax burden was imposed which inevitably resulted in the complete stripping of the land in order to reduce the assessment, and which here and there has even caused the abandonment of the land to the States. In many southern counties the shrinkage of local revenues resulting from gradual cutting of the virgin timber, the dismantling of sawmills, and the disappearance of entire communities, has obliged local authorities to put ever-increasing assessments upon the cut-over lands and virgin timber. As long as their sawmills remain in operation lumbermen generally continue to pay taxes on their entire properties out of current manufacturing revenues, but there will be little inducement to continue this practice after the mills have closed for lack of logs.

Taxes are not, however, burdensome everywhere. The quite general uncertainty as to future assessments and tax rates is on the

whole a greater deterrent to timber growing than high assessment under existing law.

Louisiana and Alabama have attempted to meet the tax situation by offering to landowners contracts of reforestation, under which in return for protecting their lands from fire and growing trees on them the owners are assured a fixed valuation on their properties for a term of years. Some progress has been made by such measures toward removing the obstacle of heavy taxes, actual or prospective, but for a variety of reasons owners have not availed themselves of these privileges to an extent which constitutes a real solution of the tax difficulty.

COMPETITION OF VIRGIN TIMBER

As long as virgin timber in apparently inexhaustible quantities was available in the South and the price of even choice grades of lumber was so low as scarcely to reward the sawmill man adequately for his capital investment and his organizing energies, just so long was it difficult to persuade anyone that second-growth timber, knotty and (unless given preservative treatment) lacking in durability, was worth growing. The courage and foresight which caused the pioneering southern lumbermen of the nineties to invest large sums of borrowed money in cheap stumpage, which at the time had no resale value to speak of, has rarely been extended by them or their successors to a consideration of investments in second-growth lands and forests. Few lumbermen have yet come to regard seedling and sapling trees as the source of raw material for their mills 20 or 30 years in the future or land covered with such trees as a sound investment. While virgin stumpage remained at $1.25 an acre this attitude was not difficult to understand. In 1927, however, the sales of virgin yellow pine reported showed a regional average of $6.70 per M feet board measure, while the highest prices reported for both virgin and second-growth timber ran from $11 to $17.

LACK OF ACQUAINTANCE WITH THE FACTS REGARDING TIMBER GROWING

The most potent reason, however, for the failure of the southern forest landowner, either farmer or lumberman, to grow trees deliberately and systematically on his land, has undoubtedly been the average American's ignorance of timber culture. Many men, even those who have been brought up in the woods, or who have logged the timber off thousands of acres, still doubt whether certain of the southern pines will reproduce. The belief is quite common, for example, that longleaf pines will not produce longleaf seedlings and saplings, and that if they reproduce at all, they will generate shortleaf pine. Many southerners regard the fire-stricken, ragged thickets of young pine of any species as a kind of "scrub" which will never grow to usable size or produce valuable wood. The facts given here concerning the easy reproduction and development of pine stands are not generally understood. Chief of all, lack of reliable information as to just how fast second-growth pine trees grow has discouraged attempts at reproducing and caring for them.

The fact that in the virgin forest pine trees of good size average from 125 to 175 years of age has caused a great many people to conclude that timber growing by private agencies is out of the question except as a philanthropic venture. They have been unaware that conditions for

rapid growth in cut-over lands, old fields, or hurricane-swept areas are very much more favorable than in the virgin forest, where the seedlings and young trees must struggle for light in the shade of surrounding larger trees, and for soil moisture within the zone of their roots. The second-growth stand has little competition except within itself, and can produce a tree of given size in half the time required in the original forest, or less. (Fig. 3.) Quality is sacrificed to quantity in second-growth stands if an excessive rate of growth, such as takes place in too open stands, is permitted. But since lumber is now sawed from much smaller trees than formerly, the owner of second-growth southern pine may look forward to harvesting a crop of saw logs of satisfactory quality from trees grown not merely within his lifetime, but within a little more than a generation. Were this generally known, forestry in the southern piney woods would long since have become a more common practice.

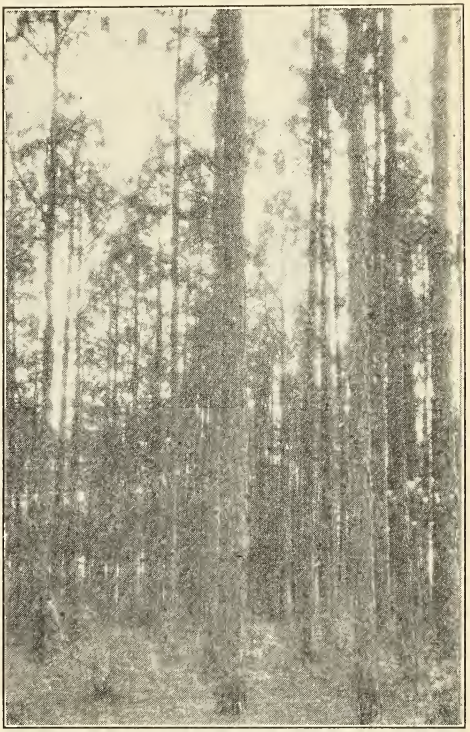

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FIGURE 3.—Second-growth pine ready for the saw. This well-stocked stand of longleaf pine in Georgia is 58 years old; the trees range from 6 to 16 inches in diameter breast high, and are about 75 feet tall

PRACTICAL EXAMPLES OF TIMBER GROWING IN THE SOUTH

Timber growing has been undertaken more extensively in the South within recent years than is generally realized. In spite of the fire risk, uncertainty as to future taxes, the presence still of great quantities of virgin timber, and ignorance as to the precise rate of growth of trees, many owners of pineland are now growing forests as a business venture. Some are doing this with a considerable degree of intensiveness and thoughtful planning.

Thoroughgoing forest management on private holdings, comparable to that on the national forests to-day (*8*), requires a careful survey of the owner's resources, present and future, and a restriction of cutting to the amount of wood which may be grown yearly. Such surveys have not yet been made, nor cutting policies in accord with them adopted, by more than a few owners of large southern pine properties. It is interesting to note, however, that these properties include tracts managed for pulp, naval stores, and lumber. On the other hand, examples of conservative cutting, or fire protection, or artificial forestation, or combinations of all of them in varying

degree, may be found in every Southern State. Two of these tracts, the first a farmer's woodland, the second one of the largest privately owned forest tracts in the United States, are described as illustrations of what is already possible in private forestry practice.

A farmer of the piedmont section of Georgia has for the past 20 years handled his shortleaf pine woodlands in such a way as to obtain, at intervals of three to five years, a cut of saw logs attractive to a portable-sawmill operator. Instead of permitting the sawmill man to cut everything that will make "two slabs and a streak of sawdust," he sells no healthy trees under about 12 to 15 inches in diameter. Diseased, overcrowded, and insect-infested trees, and those otherwise injured or unpromising, he marks for cutting without regard to size. By means of a carefully drawn contract and personal supervision of the marking he makes sure that logging does not injure any trees left standing, and that the milling is properly done; the stumpage he sells on the basis of mill tally. Following logging, the tops are cut into cordwood, and fire is carefully kept out of the little slash that remains. (Fig. 4.)

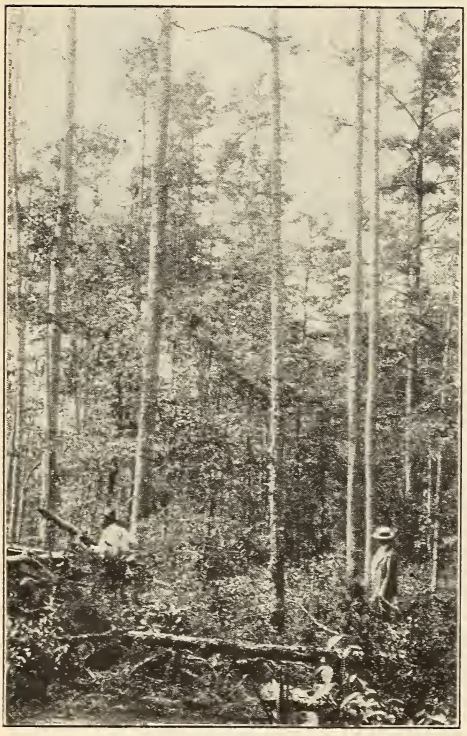

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FIGURE 4.—A Georgia shortleaf pine farm woodland carefully handled. Limbs and tops are being converted into cordwood, following cutting of saw timber to a diameter limit

The diameter limit results in the cutting of trees as they reach 40 to 50 years of age, and leaves on the average acre 10 to 20 younger trees of seed-bearing size. These reserved trees are sufficient in size and number to furnish a heavy seed crop within a year or two of the cutting, and in 10 years to mature into saw logs. This owner has demonstrated to his own satisfaction over a period of years that a policy of timber growing pays.

A lumber and pulp company owning upwards of 425,000 acres in Louisiana and Mississippi began its forestry practice about 1920. Fires, in spite of some effort on the part of the State authorities in Louisiana, who had been handicapped by lack of funds, burned nearly every year over most of the property. Encouraged by that State's broad-minded taxation policy toward lands being reforested, the company undertook a comprehensive forestry program in Louisiana which it believes will enable it to operate its pulp mill, and possibly its sawmill, indefinitely.

Its fire-protective organization for its main tract of 250,000 acres, including some land in other ownership, consists of a chief ranger, employed yearlong; a patrolman to every 25,000 acres, who patrols his territory and fights fires during a season normally of about five and one-half months, from November 1 forward; and a towerman, or

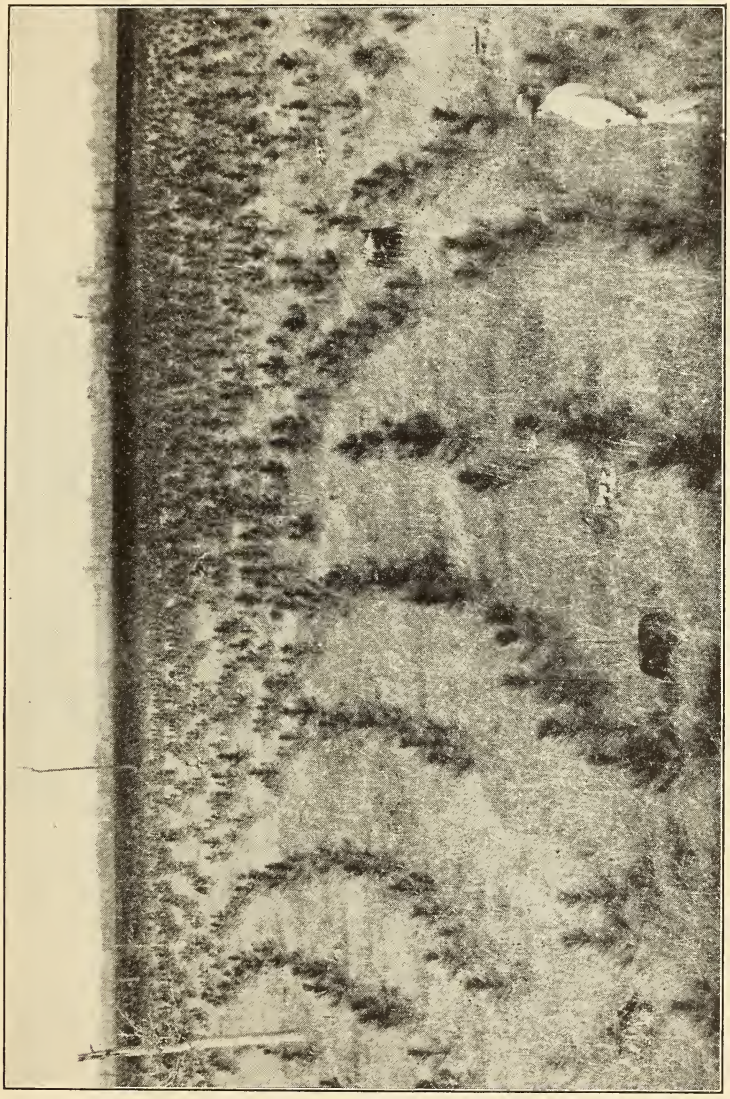

FIGURE 5.—A commercial plantation of slash pine in Louisiana. Three-year-old plantation (four years from seed) for pulpwood and saw logs, part of many thousand acres artificially reforested by a single company

lookout on a steel tower, connected by telephone with headquarters, with most of the patrolmen, and with the logging camps. Ten-foot, tractor-plowed fire lines around every quarter section of artificially forested land, and 50-foot burned strips around every section of

virgin timber, have been installed at costs of about $23 and $8.50, respectively, a mile. Hog-proof fences costing $200 a mile have been built around 50,000 acres at an acre cost of about 50 cents. These serve to exclude razorback hogs (cattle grazing is not prevented, but rather encouraged as a means of reducing fire hazard), and respect for the property values involved in the fences is believed to have considerable effect on the public attitude toward fires. These measures and a general educational campaign against burning and in favor of timber growing cost the company annually from 3.5 to 8 cents an acre, depending on the year. Its efforts to prevent and control fires have met with most encouraging results, the percentages of the total area burnt over having been 2, 6.8, and 5.5, respectively, in the three fire seasons, ended in the spring of 1927. Despite incendiarism by one or two individuals, the community sentiment against fires has steadily improved.

Areas cut clean prior to the adoption of the company's forestry policy are being artificially reforested. A nursery which has contained as many as 7,000,000 longleaf, loblolly, and slash pine seedlings is in operation, and about 4,000 acres a year have been planted, with a satisfactory percentage of success. (Fig. 5.) The company reports remarkably low costs. One-year-old planting stock was produced for 69 cents a thousand seedlings; and the land was planted with about 900 seedlings, spaced 6 by 8 feet, for $2.75 an acre, exclusive of the cost of stock. These costs are for an exceptionally favorable year. A little less than $5 an acre for the two items together is probably a better figure for the average commercial plantation of southern pine.

Seed trees are being left in all current cuttings. On each acre at least one vigorous tree 10 inches in diameter at breast height, or as much larger as conditions require, is selected for seed before logging and turpentining begin, and in addition the forester in charge leaves as many trees below 10 inches as he believes desirable. Slash or tops, remaining after pulpwood has been cut out of the upper parts of the trees felled for saw logs, are removed from the base of all seed trees.

FOREST INDUSTRIES A CHIEF SOURCE OF SOUTHERN PROSPERITY

The forest industries of the South now hold a position of commanding importance among southern manufactures and represent a chief source of southern prosperity. In value of their products, lumber and timber, according to the Fourteenth Census (1919), rank first among all manufacturing industries in Arkansas, Florida, and Mississippi; second in Louisiana; third in North Carolina and Virginia; fourth in Alabama and South Carolina; and fifth in Georgia and Texas. The census does not separate the industrial statistics for the pine-using industries from those dependent on other kinds of wood; separate figures based chiefly on the relative cut and value of pine have been computed by E. L. Demmon, director of the Southern Forest Experiment Station, from the census figures. These are summarized in Table 2.

TABLE 2.—*Statistics of southern pine manufacturing industries with percentage relationship to total of manufacturing industries in the South, by States, 1919*

State	Persons engaged		Salaries and wages		Value of products		Taxes paid by industries	
	Number	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*	*Dollars*	*Per cent*
Virginia	14,312	10.3	11,464,720	7.9	29,212,092	4.5	516,567	1.5
North Carolina	23,311	13.3	18,581,281	12.7	48,826,909	5.2	699,088	.6
South Carolina	12,425	14.4	10,376,527	14.2	22,903,452	6.0	346,361	1.9
Georgia	17,098	12.1	12,574,288	9.9	34,828,259	5.0	455,229	2.3
Florida	22,178	26.7	18,399,746	23.5	43,553,376	20.4	880,699	13.2
Alabama	28,237	23.4	21,580,358	18.3	53,897,643	10.9	801,188	8.3
Mississippi	34,274	53.2	30,215,375	51.1	75,789,802	38.3	2,117,846	48.4
Louisiana	37,312	33.2	39,347,755	33.5	99,410,520	14.7	5,733,815	21.0
Texas	21,621	16.5	22,492,911	15.2	58,599,695	5.9	1,631,115	12.0
Arkansas	21,209	36.4	19,789,566	35.0	50,610,452	25.3	1,516,058	39.0
Oklahoma	2,520	6.6	2,590,025	5.5	6,692,874	1.7	224,674	4.5
Total or average	234,497	20.4	207,412,552	18.5	524,325,074	9.0	14,922,640	5.6

Because of lack of uniform cost accounting in the forest industries, as in most others, the Bureau of the Census warns against over-reliance on its figures for invested capital and makes no attempt to include in those for the forest industries the investments in timberlands and standing timber. Information from other sources has therefore been combined with that taken from the census to give the following approximate sum for each Southern State, representing the total investments of the pine industries in sawmills, logging railroads, equipment, and stumpage, but not in cut-over land or the land itself under standing timber:

Virginia	$35,000,000	Louisiana	$235,000,000
North Carolina	90,000,000	Texas	140,000,000
South Carolina	55,000,000	Arkansas	90,000,000
Georgia	50,000,000	Oklahoma	10,000,000
Florida	100,000,000		
Alabama	120,000,000	Total	1,130,000,000
Mississippi	205,000,000		

This total of $1,130,000,000 is about a quarter of all the capital invested in manufacturing in these States. Stumpage not now in the hands of actual sawmill operators is not included.

These figures are impressive. Yet figures alone can not measure the value of the pine-manufacturing industries to the South. Before the coming of the great pine sawmills vast stretches of the South were a wilderness, without population, communities, roads, schools, or any of the institutions of modern, progressive life. "Pine barrens" was the name given to them in some States, and it is indicative of the general public's estimate of their worth. The sawmills brought prosperity into the barrens. They built towns and railroads. They created communities and markets. Where the soil was fertile or other conditions favorable they gave millions of acres to agriculture. When production reached a peak of over 16,000,000,000 feet in 1909 the piney woods were in their heyday.

TIMBER GROWING AS A CHECK TO THE DECLINE OF FOREST INDUSTRIES

The cut of southern pine lumber has declined slowly but quite perceptibly since 1909. Some of this decline has been shared by the Nation's lumber industry as a whole, and has nothing to do with

waning supplies of raw material. Some of it is a paper decline rather than an actual one, for the extraordinary increase in number of small portable sawmills in the South within the last few years has made it impossible to obtain, by methods generally at the disposal of the recording agencies, an accurate account of all the lumber cut. But the remainder of the decline is due to no other cause than that the southern pine industry is cutting saw timber three times as fast as it grows and that the area of virgin pine is being reduced at the rate of about 1,340,000 acres a year. In 1927 only about 41 per cent, by volume, of the standing pine of saw-timber size was original growth.

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FIGURE 6.—Dual-purpose trees. These 34-year-old slash pines on an old cutting in Florida are part of an experiment to determine the best methods of turpentining. Two hundred and forty cups an acre have been hung on trees 9 inches and larger at breast height

To the timber cut must be added the loss in growth from current wasteful methods of turpentining. These stunt the trees, lay them open to damage by fire, insects, rot, and wind, and in many instances kill them outright. (Fig. 6.)

So severely are the stands of second-growth longleaf and slash pine being turpentined, and culled for ties, poles, and piling, that their annual production of saw logs is only one-fourth the quantity cut from them. As the result of wasteful turpentining and the cutting of fuel and other small material, relatively few saw logs develop in the sapling and cordwood stands. Since in virgin stands of all species in the South growth is fully offset by loss from fire, insects, disease, and wind, the second-growth stands of shortleaf and loblolly pines remain as the only substantial source of new saw timber. Surprising quantities of second growth have developed in every Southern State on old cut-over lands and abandoned fields, in spite of the fires which, although less frequent and widespread than in the longleaf areas, have swept them at intervals for many years. These second-growth shortleaf stands, whose development had gone unnoticed as long as virgin shortleaf and longleaf timber remained in vast quantities, are to-day the basis for a portable-sawmill industry which has amazed many large sawmill men, contemptuous of second growth. So heavy are the inroads upon this timber that it is now being cut 1.3 times as fast as it is growing.

Thus, although the absolute quantity of lumber, ties, poles, piles, and other material of saw-log size taken from the pinelands of the South during the 10 years from 1915 to 1925 shows but a small decline from the quantity removed in the previous 10 years, when the virgin forests were referred to as inexhaustible, the pace can not be maintained. A substantial reduction in yearly cut within the next decade, or even less, seems entirely probable. This reduction will not come all at once, because when the large pine sawmills cut out, as they are doing almost monthly, small mills in the same or other localities take their place in some measure. But in concrete terms, a reduction of 1,000,000,000 feet in the total output of southern pine involves, on the basis of the figures in Table 2, the laying off of about 18,000 men in the sawmills, the logging camps, and associated manufacturing enterprises. A yearly pay roll of nearly $16,000,000 is wiped out. Forty million dollars of wealth is no longer annually created for circulation among merchants, farmers, and professional men, or for deposit in banks. Upwards of $1,140,000 is missing from the taxes which support schools, roads, and civil government generally. Should the apparently inevitable reduction in the cut of southern pine be not 1,000,000,000 but several billion feet the industrial losses will be staggering, indeed.

There is, however, no reason why the South should suffer permanently such losses in its industrial life. There is a way to check the decline in the enormously valuable pine-manufacturing industry and to restore to full productivity the 102,000,000 acres of cut-over pineland. That is to grow more timber.

For the majority of large sawmills it is too late to consider perpetuating present operations at full capacity through timber growing. A sawmill of large capacity which has been cutting its lands clean for many years and has only enough timber remaining for a few years' operation can not now consider growing a new crop of timber from which to supply the existing mill with logs. On the other hand, many pine mills, including some of large capacity, could plan on continuous operation from the growth on their lands, if they were willing to accept some reduction in present rates of cutting. A few are already doing so. Among those companies that became interested in forestry too late to be able to extend the life of their mills indefinitely, some have seen the wisdom of protecting their cut-over lands against fire as a means of turning them from a liability into an asset. It is enterprises such as these, and in time new enterprises based on a sounder land policy, which will preserve the prosperity of the South as represented in her forest industries. That the growth of the southern pines is ample to justify this hope is apparent from the information presented in this circular.

The fear is sometimes expressed that second-growth southern pine will be of such small size and inferior grade as to be incapable of holding its place in the future lumber markets of the Nation. Fortunately, this fear is partly based on certain present conditions which some well-planned effort by timber growers and manufacturers may be expected to correct. Some second-growth saw logs come from stands which, originating from insufficient seed or later decimated by fires and other destructive agencies, were too open to produce clean stems and trees of a moderate rate of growth. These inferior logs have

then in many cases been very carelessly sawed, and the lumber from them imperfectly dried and often not graded at all. The large knots, coarse grain, uneven dimensions, warping, and blue stain of such

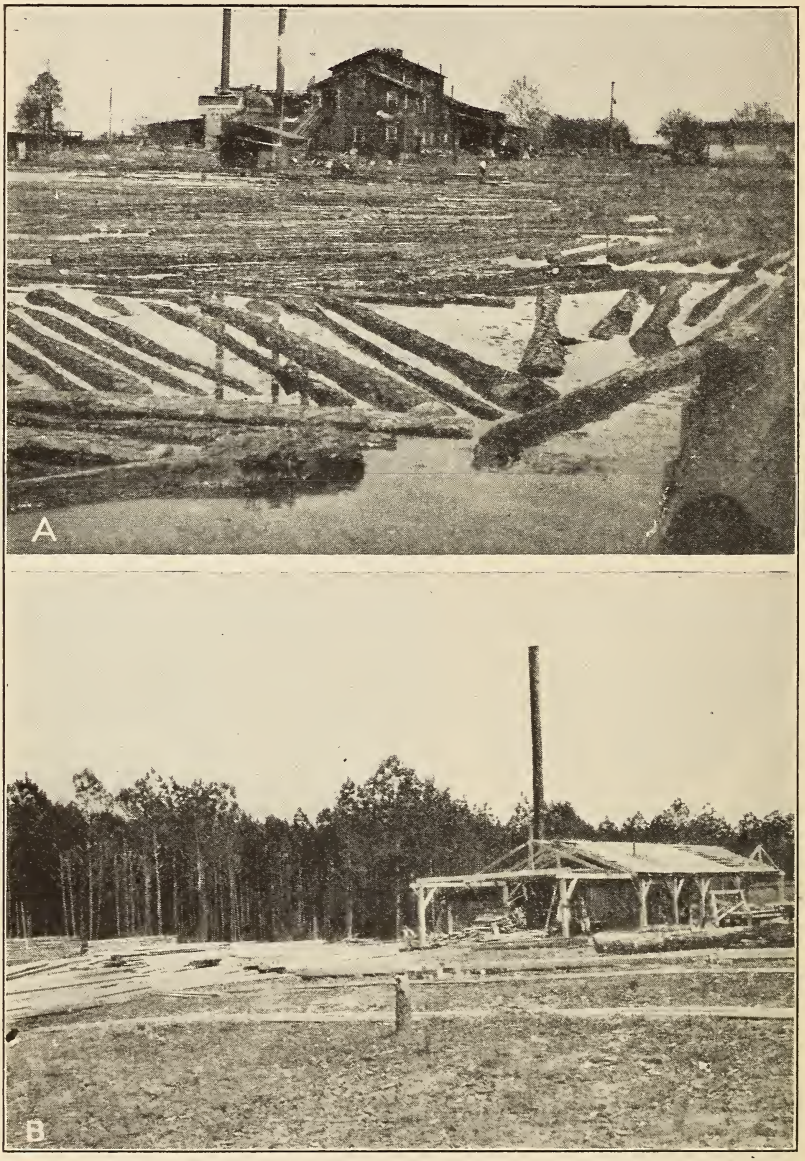


FIGURE 7.—Mills that prosper on second-growth southern pines. A, a well-equipped band sawmill in North Carolina cutting second-growth timber almost exclusively; B, mills of the type of this Virginia portable mill have sawed billions of board feet of second-growth pine

lumber have combined to give second-growth southern pine an unenviable reputation in many quarters. Dense stands, on the other hand, such as may be grown under skillful forest management and

with adequate fire protection, yield logs of a much higher quality, and careful manufacture produces from them lumber of very serviceable grades.

The best indication that second-growth pine is capable of meeting future demands is in the extensive use for generations of second-growth pines in Virginia and North Carolina. (Fig. 7, A.) This has now spread into nearly every Southern State, through the establishment of hundreds of small sawmills cutting second growth. (Fig. 7, B.) These mills have found a profitable market for their output, in spite of careless manufacture and an average grade of lumber below that which may be produced in the future. The growing number of southern pulp mills suggests close and economical use, both in the mills and in the woods, of such material as will not make boards or dimension. Other industries prosper on second growth. (Fig. 8.)

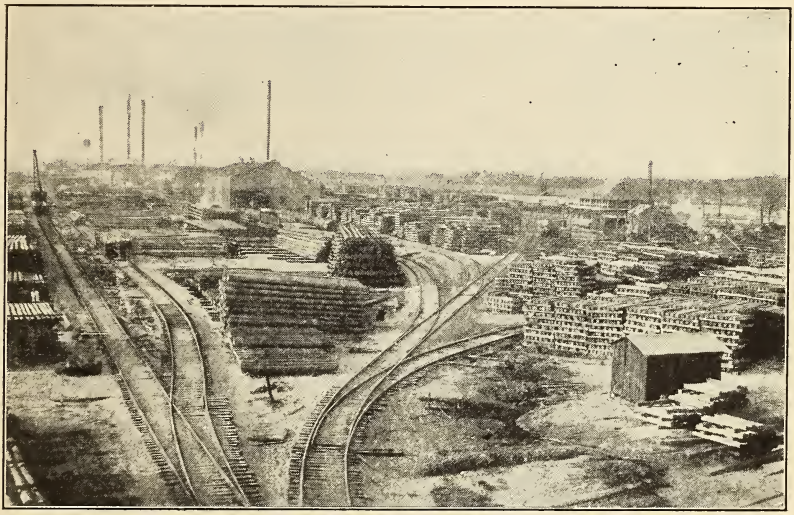


FIGURE 8.—Many minor industries are subsisting on second-growth southern pines. This Texas pressure plant draws most of its material from second-growth stands

NATIONAL DEPENDENCE ON SOUTHERN PINE PRODUCTS

Since 1899 the southern pines have furnished from 30 to 50 per cent of the Nation's lumber and to all practical purposes all of its naval stores (*14*, *17*). They have been the source of a steadily increasing proportion of the Nation's pulpwood, reaching one-eighth of the domestic production in 1926 (*18*). Ties, piling, poles, and even posts have been shipped in vast quantities out of the southern pineries.

An analysis of figures on lumber distribution, recently made by R. V. Reynolds and A. H. Pierson, of the Forest Service, indicates that in 1926 a larger quantity of lumber was shipped from the southern pine mills of the 11 chief producing States into each of the following States than was produced within each of those States during the same year: Connecticut, Delaware, Illinois, Indiana, Iowa, Kansas, Maryland, Massachusetts, Missouri, Nebraska, New Jersey, New York, North Dakota, Ohio, Pennsylvania, and Rhode Island. That this should be so for the prairie States, or those whose forests have

been largely replaced by farm crops, is not surprising. But it is worth noting that Missouri's entire lumber cut from her own forests is but 54 per cent of the quantity of yellow pine lumber she receives from the southern pineries; Massachusetts's, 43 per cent; Pennsylvania's, 38 per cent; Maryland's, 33 per cent; New York's, 21 per cent; Ohio's, 21 per cent; and New Jersey's, 2 per cent. Even Michigan, once the premier lumber-producing State of the Union, shipped in a volume of southern pine which was double her own production of softwoods.

Already the South, including some States which produce only very small quantities of southern pines (Kentucky, Tennessee, and West Virginia), consumes half of the cut of these species. As depletion of the standing timber brings about reduction in the southern pine cut, and as this reduction may be measured in billions of board feet, it seems clear that the rapidly growing demands of the South itself will leave less and less lumber available for shipment into the North and Middle West. Earlier analyses of distribution indicate that the South's consumption of her own pine increased steadily from 42 per cent of the total cut in 1922 to 51 per cent in 1925. In other words, the shortage of southern pine lumber will be felt not so much in the States where it is produced as in other States, which are therefore vitally interested in the growing of more pine in the South. Although lumber will unquestionably be obtainable from other forested regions, it will be only at prices which reflect the withdrawal from competition of a hitherto abundant and valuable species.

The Nation's interest in a continuance of the naval-stores industry, which to-day is an industry peculiar to the southern pineries, is suggested by a mere list of a few of the universally used products of which either turpentine or rosin are important ingredients: Paints and varnishes, soap, coated papers, printer's ink, linoleum, and oilcloth.

GENERAL INFORMATION REGARDING THE TABLES

DEFINITION OF TERMS

The information on rate of growth of the four chief species of southern pine is given in the form of volume tables, yield tables, and stand tables. All of it is for second-growth trees and stands, and the yield and stand tables are for pure, even-aged, normal stands. These terms require definition.

SECOND GROWTH

Second growth is the term applied to trees which developed from seed or sprouts following the cutting of the virgin forest, or which were but a few years old at the time of cutting. It is used rather loosely to cover forests which may actually be third growth, fourth growth, etc. It excludes scattered trees of an earlier forest which were old at the time the bulk of the forest was cut, but were for some reason left standing. Timber growth which follows a hurricane, a destructive fire, or a "worm deadening," is as much second-growth as that which follows a cutting, although it is not ordinarily called second growth.

STAND

A stand is a forest or part of a forest in which conditions are uniform in important respects, such as age of the trees, their species, or density of the stand. For example, there are even-aged and all-aged stands; pure stands and mixed stands; open stands and dense stands, among many others.

VOLUME TABLE

A volume table is a table showing the volume of wood contained in trees of various diameters and heights. The volumes given in the present bulletin are expressed in cords, both of rough or unpeeled and of peeled wood and in board feet by the International and Doyle rules. The volumes are such as will be obtained when the trees are cut into sections of proper size, either for stacking and measurement in cords or for scaling as saw logs. It is assumed that the trees will be used to a specified size in the top, that they will have only an average amount of crook, are not forked-topped, and are free from rot. The quality of the wood—that is, with respect to knots or similar defects—is not indicated, but it is assumed that any one using the tables will take into consideration the size of the tree in judging the quality of lumber which it is likely to produce.

YIELD TABLE

A yield table is a table showing the yield, or volume of wood in cords, board feet, or other units, which may be obtained at varying ages from a unit (in the United States an acre) of forest land. It will be seen that yield tables refer to stands and volume tables to single trees.

STAND TABLES

A stand table is a table showing the number of trees of various diameters which are found on an acre or other unit of forest land. It therefore indicates the range in size (diameter) of the trees in the stand.

PURE STAND

A pure stand for the purpose of this bulletin is a stand in which 80 per cent or more of the trees are of a single species.

EVEN-AGED STAND

An even-aged stand is one in which the oldest and youngest trees do not differ in age by more than 10 years; 5 years is more often the greatest spread encountered in second-growth southern pine stands.

NORMAL STAND

A normal or fully stocked stand is one having the average maximum volume of wood (not necessarily merchantable wood) for that species, age, climate, and soil. The stands measured as a basis for the figures given in the tables were selected portions, each less than an acre in extent, of natural or volunteer origin. These areas were chosen for measurement because they represented the best growth which could be found. Very few had wholly escaped stunting by fire. Stand volumes as high as theirs have not been attained (less often exceeded) on more than a fraction of the many million acres of second-growth pine in the South. Vast areas of cut-over pineland are producing no wood at all. Between these and the land bearing fully stocked

stands there are other millions of acres whose production varies all the way from 10 to 100 per cent of the figures given in the tables. Occasional thickets, of course, have more wood in them than the fully stocked stands represented by the tables, but these are even smaller than the fully stocked stands.

Abnormal stands, either understocked or overstocked, which were measured by chance in collecting the information from which the yield tables are made, were later eliminated from consideration in constructing the tables. Even then there was considerable variation in the figures used, and it should be remembered that the table values for any site class are not the highest yields measured in the course of the study, but averages of all samples retained as being normally stocked.

WHY NORMAL YIELD?

Normal stands represent the full capacity of a given quality of soil to produce wood under favorable natural conditions, and their growth represents normal yield. Since partial stocking is very much more common than full stocking, the question may be asked: Why were not yield tables prepared for partially stocked stands which would more nearly reflect ordinary conditions? The answer is that such tables, unless based on measurements of the entire second-growth pine acreage of the South, would not be representative of anything but the particular areas which happened to be measured in the study and would give no idea of what might be produced under even the more favorable of present conditions.

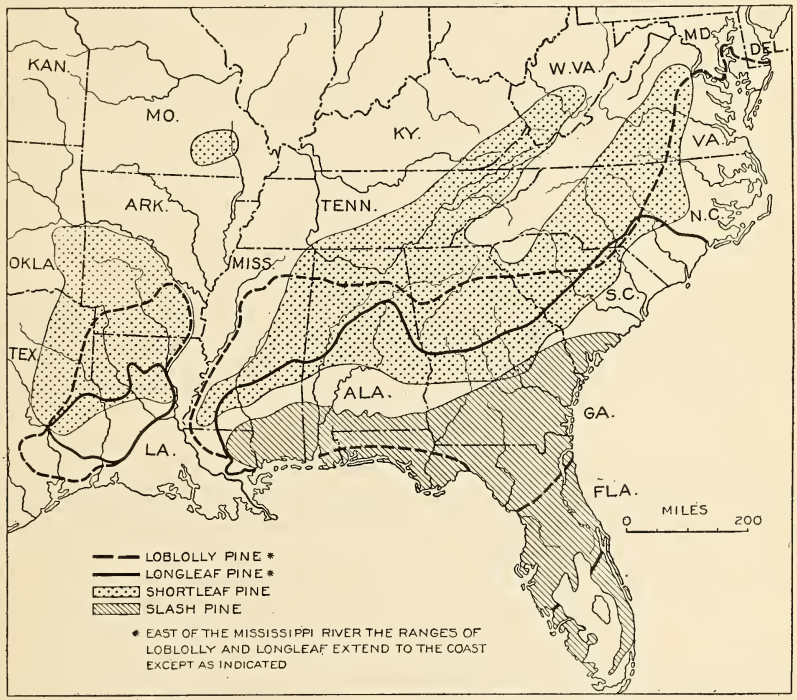
Normal yields of timber may be compared to the figures which are used by every farmer or purchaser of farm land in describing his property. When a man speaks of "25-bushel cornland," or "half-bale cotton land," he does not mean that this land will produce 25 bushels of corn or half a bale of cotton to the acre every season, the bad along with the good. Nor does he mean that those quantities of farm produce can be obtained from the land no matter how shallowly it is plowed, how poorly it is planted, how carelessly cultivated, or how inadequately fertilized. "Twenty-five bushel cornland" means to him land which, if properly plowed, planted, cultivated, and fertilized, will in an average year produce 25 bushels of corn to the acre. "Half-bale cotton land" is that land which will produce half a bale of cotton per acre in an average year of suitable conditions. These quantities might be termed the "normal yields" for such land, as the forester uses the term.

The reason that the yield of timber shown in the tables which follow will appear to many as abnormal rather than normal is that few Americans are acquainted with forest land in full productivity. The average grade of agriculture practiced in this country has probably kept the land in fuller productivity than the best forestry yet practiced. However, the South is gradually moving toward fire control and the control of other agencies which injure or destroy tree growth. There is every reason to believe that even such small assistance from man as prevention of fires, for which he is now largely responsible, will substantially increase the present average yields; and that more intensive care, such as the thinning out of stands too thickly grown with young trees, will result in the production not only of equal or greater quantities of material but also material of very much higher value than that produced at present in natural forests.

Since some pineland has already been found producing wood at the rate shown in these tables, even with chance natural seeding and no more than a little fire protection, there is every reason to believe that any pineland in the same site class can produce wood at the same rate if given adequate care.

HOW TO IDENTIFY THE FOUR SOUTHERN PINES

Separate volume, yield, and stand tables have been prepared for each of the four principal species of southern pine. Loblolly, longleaf, shortleaf, and slash pines differ materially not only in the volume of wood contained in individual trees of like diameter and height, but



COMMERCIAL RANGE OF SOUTHERN PINES

FIGURE 9.—Commercial range of the principal southern pines. The commercial range is the territory in which each species is cut in important quantities, or turpentined in extensive orchards. The botanical range, except for slash pine, is somewhat more extensive than the commercial range

also in the volume of wood which they produce to the acre at a given age, under like conditions of soil and climate. It is, therefore, very important that those who use the tables make no mistake in identifying the species to which the tables are to be applied.

Unfortunately, there is a general inconsistency in the names which are applied to the four species in the vast territory from Virginia to Texas, the same name frequently being applied to two distinct species. Many lumbermen and farmers, for example, do not attempt to distinguish between shortleaf and loblolly pine, or even between slash and longleaf pine. The following brief description of the range and

distinguishing characters of each species should serve to prevent wrong use of the tables.

LOBLOLLY PINE

Loblolly pine (*Pinus taeda*) is very widely distributed (fig. 9), and flourishes on probably a greater variety of soils than any other southern pine. In the original virgin forests of the South it was, however, largely confined to lands where moisture was abundant, and it grows most rapidly and to the largest size in the bottom lands along small streams, where it is generally found associated with hardwoods. It is rarely, however, found on lands which are overflowed for more than a day or two at a time. For a variety of reasons loblolly has followed longleaf pine, on many areas in the South, as a second crop after the virgin timber was cut, particularly near the limits of the longleaf's range.

The needles, or "straw," of loblolly pine are 6 to 9 inches long, and are intermediate in length between those of longleaf and shortleaf pine. As with all pines, the needles grow in a bundle or cluster surrounded by a paperlike sheath at their base, and when they fall from the tree the bundle is unbroken. Loblolly needles grow three in a bundle. The cones or burs, like the leaves, are intermediate in size between those of the longleaf and shortleaf, and are generally 3 to 6 inches in length. The tips of the branches (growth of the current year) are rather slender, the size of a lead pencil, or less.

Loblolly pine is quite generally included with true shortleaf pine under the latter name. It is also frequently called "old field pine," because it so often comes up in abandoned fields. This name is not distinctive, however, since all of the other pines will likewise come up in old fields.

LONGLEAF PINE

Longleaf pine (*Pinus palustris*) grows both on dry upland soils, in which its long and heavy taproot apparently gives it a great advantage in its downward search for water, and on flat, poorly drained crawfish land. Other names applied to longleaf are "yellow," "long-straw," and "hill" pine. The name itself identifies longleaf very well, since its needles are the longest of any American pine's, from 8 to 18 inches in length. After the first year, the leaves of longleaf pine are borne three in a bundle, but before that 2-needled bundles are common. The cones of longleaf sometimes reach 10 inches in length but are ordinarily 6 to 8 inches. The tips of longleaf pine branches are extremely stout—almost the size of a man's finger.

SHORTLEAF PINE

Shortleaf pine (*Pinus echinata*) resembles longleaf in its ability to grow in dry soils, and is able to withstand lower winter temperatures than any of the other southern pines, growing to saw-log size as far north as New Jersey and as high in the Southern mountains as 2,500 feet (*11*). It is therefore common over a wider range than any other of the southern pines.

Shortleaf, like longleaf, is well distinguished by its name, the needles being only 3 to 5 inches long. Many of them are borne in bundles of two, in contrast to the three's of longleaf and loblolly. Shortleaf has also the most slender branchlets of the three. The

cones are only 1.5 to 2.5 inches in length, the smallest among the four important pines.

Shortleaf pine is generally called by that name, although very old, slow-grown specimens which have a comparatively smooth and very yellow bark are locally spoken of as rosemary pine. Yellow pine is another common name in regions where longleaf pine is absent or uncommon.

SLASH PINE

Slash pine (*Pinus caribaea*) is normally found in wet places, although it seems to be an aggressive species capable of growing also on higher ground. Its present range is smaller than that of the other pines. Slash pine needles are on an average only a little shorter than those of longleaf, a tree it closely resembles. However, their greatest length is only about 12 inches, and the large proportion of them on any vigorous branch have only two needles in a bundle, in contrast to the three's of longleaf pine. The ends of the branches are a little less stout than those of longleaf; the brown winter buds are in strong contrast to the woolly white buds of longleaf. The cones are generally a little larger than those of loblolly.

VOLUME TABLES

EXPLANATION OF TABLES

What a volume table is has already been explained. In the following tables volumes are given, separately for each species, in cords of rough wood, that is, wood with the bark on; cords of peeled wood; board feet by the International log rule; and board feet by the Doyle rule. The cordwood tables (Tables 5, 8, 11, and 14) for each species are combined in one, to save space. Volumes in board feet by the International rule are given (Tables 6, 9, 12, and 15) for heights expressed both in number of logs and in feet of total height. Volumes by the Doyle rule are given in Tables 7, 10, 13, and 16. Information as to stump height, diameter to which the trees are measured in the top, and other details necessary to a clear understanding of the tables, is included in footnotes to each. Certain terms, used either in the headings or footnotes, require further explanation.

Diameter breast high.—This term, often written "d. b. h.," signifies the diameter of the tree, outside the bark, at a point 4.5 feet above ground. Included within any inch class are all diameters within a half inch above or below the even inch; for example, any tree between 8.6 and 9.5 inches is considered as a 9-inch tree. Trees smaller than 4 (3.6) inches are regarded as having no cordwood volume; those smaller than 7 (6.6) inches, no volume in board feet by the International rule; and those smaller than 9 (8.6) inches, no volume in board feet by the Doyle rule.

Number of 16-foot logs.—Since trees not containing a full 16-foot log are commonly considered unmerchantable, and since all trees containing less than 1¼ logs (to a top diameter of 5 or 7 inches as specified in the table) would be scaled as having the same board-foot volume, 1-log trees are omitted, and the tables begin with trees containing 1¼ logs.

Total height.—Total height is measured from the surface of the ground to the extreme tip of the tallest branch.

Basis.—Only a relatively small number of trees of each diameter or height appearing in the tables were actually measured. It was possible, however, by careful study and comparison of all measured volumes, to arrive at a reliable average for each combination of height and diameter represented, and even to calculate volumes for a few combinations not represented. The vertical columns headed "Basis" show how the measured trees were distributed between diameters regardless of height, and the horizontal columns how they were distributed between heights regardless of diameter.

Blocked-in figures.—The heavy ruled lines surround the measured values; values outside are calculated only.

Volume in cords.—A cord of stacked wood, carefully piled and closely trimmed, occupies a space 8 feet long, 4 feet high, and 4 feet wide, or 128 cubic feet; but the actual volume of solid wood, or wood plus bark, in a cord of loblolly pine varies from 84 cubic feet, when the trees from which the sticks are obtained average 4 inches in diameter, to 98 cubic feet when the trees average 14 to 18 inches. (Table 31.) Peeled wood does not appear from experiments to stack any closer (that is, with any less air space) than wood with bark. No actual tests have been made for other species but it is believed that the loblolly values hold for longleaf, shortleaf, and slash pines as well. Limb wood is not included in the values given.

Volume in board feet.—The volume of a tree in board feet depends not only on its diameter and the number of logs contained in it, but on the log rule used in scaling the contents of those logs. There are many log rules in current use in the United States, but of these only two are of interest in this bulletin. These are the Doyle rule, which has been commonly used throughout the greater part of the South since larger-scale lumbering began in this region, and the International rule. Of these the Doyle has little to recommend it except easy calculation and long-established use, and the substitution of the International rule is very strongly urged. The International rule appears in the Appendix, p. 74. It seems unnecessary to give the Doyle as well, since Doyle values are readily obtained for 16-foot logs by subtracting 4 inches from the upper diameter of the log, and multiplying the remainder by itself; the volumes of logs longer or shorter than 16 feet are proportionate to their lengths.

THE INTERNATIONAL RULE VERSUS THE DOYLE RULE

It is the common experience of everyone who has ever manufactured a log in the South that the Doyle rule does not begin to give the full amount of lumber which can be sawed from small, sound logs with ordinary care and with proper equipment. Even in virgin-timber operations, where the average log is large and the Doyle rule is best applied, the overrun, or percentage by which the actual amount of lumber sawed from a given lot of logs exceeds their scale, is from 10 to 25 per cent when the Doyle rule is used.

The overrun increases enormously as the size of the log decreases. In 1924 a band sawmill in the shortleaf pine region made a test run with 961 rather small logs from a virgin stand, to determine the actual contents for comparison with the Doyle scale. The logs ranged from 6 to 22 inches in diameter, the narrow way at the small end, and from 12 to 20 feet in length. The average was about 11 inches in diameter

and 16 feet long, scaling 51.4 board feet at the mill. In its effect on the overrun the rather wide 5/32-inch saw kerf tended to offset the large amount of 2-inch lumber cut, 50 per cent of the total. The average overrun of 74 per cent would have been reduced by 10 per cent if planing-mill waste, breakage in the mill, etc., were taken into account, but even so, it is large enough to demonstrate fully that the Doyle rule gives absurdly low values for small logs. The percentage of overrun by inch classes, as furnished by the sawmill company, is shown in Table 3.

TABLE 3.—*Overrun, mill tally over Doyle rule, in virgin shortleaf pine, 1924*

Diameter of log	Overrun	Diameter of log	Overrun	Diameter of log	Overrun	Diameter of log	Overrun
Inches	*Per cent*	*Inches*	*Per cent*	*Inches*	*Per cent*	*Inches*	*Per cent*
6	[1] 73	10	107	14	44	18	30
7	[1] 127	11	91	15	39	19	13
8	195	12	71	16	31	20	19
9	127	13	57	17	30	22	22

[1] All logs smaller than 8 inches were given the scale of 8-inch logs, hence the lessened overrun in these sizes.

Logs cut from second-growth trees, having generally a more rapid taper than those from virgin trees, tend to a greater overrun, unless so knotty as to cause cull.

The International log rule is recommended in place of the Doyle because it represents more nearly what may be obtained from logs that are carefully sawed in a band mill and are not abnormally crooked or otherwise defective. The figures on which the International rule is based (see Appendix) are the actual sawed-out contents of a great number of logs of various diameters and lengths. The close utilization, in the form of narrow widths and short lengths, which was practicable in the region where the original sawing tests for this rule were made, is to-day approached in many well-equipped sawmills cutting second growth in North Carolina and Virginia. Short logs, 6 and even 5 inches at the small end, are sawed in large numbers at such mills, and the manufacture of box boards and similar products out of short and narrow material utilizes a high percentage of the wood in every log. Experience warrants the belief that a like degree of utilization will gradually be reached throughout the South.

The fact that the Doyle rule fails to credit small logs and trees with their true volume has caused the Forest Service to favor use of the International rule in its place whenever volume tables are prepared for second-growth timber.

REDUCTION OF THE INTERNATIONAL RULE FOR 1/4-INCH SAW KERF

Volumes in board feet by the International rule as given here (Tables 6, 9, 12, and 15) are for a 1/8-inch saw kerf, or such as would be obtained from trees sawed in a band mill. If band sawing, with its 1/8-inch kerf, can not be counted upon, the volume table may be converted to use with a 1/4-inch kerf, such as is commonly cut by circular saws, by subtracting 9.5 per cent from each value. Or, since this is a flat reduction, not dependent on the size of the log, the total

contents of any number of logs as obtained from the table may be decreased by 9.5 per cent to allow for the wider saw kerf.

Table 4, based on information obtained in Maryland (*6*), shows the fairly close agreement between the International rule reduced for a ¼-inch kerf and the actual contents sawed out of one hundred 12-foot logs at a portable mill cutting box shooks of 1-inch thickness, and also the wide difference between the Doyle rule and the actual contents.

TABLE 4.—*Overrun of mill tally over International and Doyle scales, of second-growth loblolly pine, Maryland*

Diameter of log at small end, inside bark (inches)	Mill tally	International ¼-inch rule		Doyle rule	
		Scale	Overrun	Scale	Overrun
	Bd. ft.	*Bd. ft.*	*Per cent*	*Bd. ft.*	*Per cent*
5	10	10	0		
6	17	15	13	3	467
7	22	20	10	7	214
8	30	25	20	12	150
9	40	35	14	19	111
10	50	45	11	27	85
11	61	55	11	37	65
12	74	70	6	48	54
13	85	85	0	61	39
14	103	100	3	75	37
15	117	115	2	91	29

APPLICATION OF THE VOLUME TABLES

Use of the volume tables in timber cruising is so readily apparent as to need little explanation. Only a few comments are necessary here. All concern the board-foot tables.

Half and quarter logs.—If half logs (8-foot) and quarter logs (4-foot) are counted in estimating the number of logs in a tree, volumes may be read from the table halfway or quarterway between whole-log values. For example, a 15-inch tree containing 4.5 logs will have a volume halfway between a 15-inch tree with 4 logs and a 15-inch tree with 5 logs, in this case halfway between 251 and 333 board feet, or 292 feet.

Allowance for defect.—In using the tables based on the International rule it is important to note that although no allowance has been made for rot, the necessary allowance for crook as commonly encountered in a large number of logs was automatically made when the rule was derived from mill tallies. Second-growth southern pine has very little defect during the first 100 years of its life, unless severely fire scarred, but if rot does occur it of course requires discounting.

Grade.—The grade of lumber obtained was not taken into consideration in making up either the log rule or the volume tables. The lumber obtainable from comparatively small, rapidly grown, second-growth timber will naturally have more and larger knots, and very much less heartwood, than lumber from virgin timber.

LIMITATIONS OF THE VOLUME TABLES

The volume tables given here should not be applied in virgin stands, for trees in these stands, having less taper, will normally have greater volumes for the same diameter and height than will

second growth,[5] nor can they be accurately used in estimating the volume of scattered trees left in earlier logging. Such trees will probably have volumes intermediate between virgin trees and genuine second growth; that is, the figures, from the second-growth tables will be low.

Geographic location has not been found to have any large or consistent effect on the volume of trees of like diameter and height, so that the volume tables should be usable in any part of the southern pine region. This does not mean that differences in taper which of course somewhat affect the volume, do not exist, but that they are more likely to result from very local conditions of soil and climate than from broad regional ones. For example, the differences in volume between pine trees of like species and dimensions, but growing some on poor soils and others on near-by good soils in North Carolina, will probably be greater than the differences between the average of North Carolina trees and those of distant Texas. That the pine soils of one southern State are better on an average than those of another is not yet established, nor is information available with which to prepare separate tables for various soil and climatic conditions. For all ordinary purposes there is little need for more than the regional volume table.

TABLE 5.—*Volume in cords of second-growth loblolly pine*

ROUGH WOOD

Diameter breast high, inches	Height of tree, in feet									Basis, trees
	30	40	50	60	70	80	90	100	110	
	Volume in cords									
4	0.00900	0.0140	0.0190	0.0238	0.0279					5
5	.0158	.0240	.0304	.0368	.0427	0.0484				28
6	.0235	.0341	.0445	.0531	.0615	.0690	0.0769			38
7	.0342	.0474	.0609	.0727	.0846	.0950	.105	0.118		61
8	.0445	.0620	.0799	.0960	.113	.128	.143	.158	0.174	53
9	.0575	.0794	.102	.124	.144	.163	.183	.204	.225	30
10	.0715	.0994	.127	.151	.177	.201	.226	.255	.280	17
11		.122	.154	.184	.215	.244	.276	.310	.340	21
12		.147	.183	.219	.258	.290	.330	.370	.450	10
13			.217	.257	.302	.342	.390	.433	.473	16
14			.252	.300	.350	.398	.451	.502	.548	14
15			.290	.347	.401	.459	.519	.572	.624	9
16			.329	.395	.454	.520	.589	.647	.706	11
17				.445	.510	.588	.660	.727	.795	14
18				.495	.568	.655	.734	.810	.882	3
19				.545	.628	.721	.810	.892	.974	6
20				.598	.691	.788	.886	.975	1.07	3
21					.753	.858	.964	1.06	1.16	1
22					.817	.928	1.04	1.15	1.26	1
23					.882	.999	1.12	1.24	1.35	
24					.947	1.07	1.20	1.33	1.46	1
25					1.01	1.14	1.28	1.42	1.56	
26					1.08	1.22	1.36	1.51	1.66	1
27					1.15	1.29	1.45	1.60	1.77	2
Basis	5	47	67	60	51	44	50	15	6	345

Volume includes stem above a 1-foot stump to a top diameter inside the bark of 3 inches. Heavy rule indicate extent of basic data.

[5] Exactly the opposite is true for logs, as stated on p. 27. That is because the contents of a log is calcuated from its diameter at the small end, whereas the contents of a tree is calculated from its diameter at breast height, or near the large end. A log having considerable "rise" from the small to the large end has a larger cubic volume, and if carefully sawed a larger board foot volume, than one of the same top diameter and a slight rise.

TABLE 5.—*Volume in cords of second-growth loblolly pine*—Continued

PEELED WOOD

Diameter breast high, inches	Height of tree, in feet									Basis, trees
	30	40	50	60	70	80	90	100	110	
	Volume in cords									
4	0.00643	0.0106	0.0148	0.0188	0.0230					5
5	.0120	.0184	.0242	.0298	.0355	0.0411				28
6	.0185	.0275	.0358	.0430	.0510	.0585	0.0670			38
7	.0260	.0377	.0490	.0593	.0705	.0812	.0905	0.105		61
8	.0348	.0497	.0650	.0792	.0950	.110	.127	.141	0.154	53
9	.0448	.0637	.0833	.103	.122	.139	.158	.179	.199	30
10	.0570	.0800	.103	.123	.145	.170	.198	.221	.245	17
11		.100	.126	.150	.178	.209	.239	.269	.298	21
12		.120	.151	.180	.215	.248	.284	.320	.355	10
13			.179	.214	.253	.294	.334	.375	.415	16
14			.209	.250	.295	.340	.388	.432	.479	14
15			.240	.290	.338	.392	.444	.495	.549	9
16			.275	.331	.385	.448	.504	.560	.620	11
17				.374	.433	.500	.568	.630	.692	14
18				.416	.483	.559	.630	.700	.768	3
19				.459	.535	.614	.695	.775	.845	6
20				.501	.585	.670	.760	.848	.921	3
21					.638	.730	.828	.920	1.01	1
22					.690	.790	.897	.998	1.09	1
23					.746	.850	.963	1.07	1.17	
24					.800	.910	1.03	1.15	1.26	1
25					.857	.975	1.10	1.23	1.35	
26					.913	1.04	1.17	1.30	1.43	1
27					.974	1.10	1.24	1.38	1.53	2
Basis	5	47	67	60	51	44	50	15	6	345

Volume includes stem above a 1-foot stump to a top diameter inside the bark of 3 inches. Heavy rules indicate extent of basic data.

TABLE 6.—*Volume in board feet, International ⅛-inch rule, second-growth loblolly pine*

BY TOTAL HEIGHT OF TREE IN FEET

Diameter breast high, inches	Total height, in feet								Basis, trees
	40	50	60	70	80	90	100	110	
	Volume in board feet								
7	18	20	23	28	35	43			35
8	20	26	32	40	50	61	70		52
9	26	34	44	54	69	83	98		30
10		44	59	72	92	110	130		17
11			76	94	119	142	166		21
12			96	119	149	177	207	240	10
13			118	144	180	214	252	289	16
14			142	172	213	253	298	340	14
15			167	201	247	295	346	392	9
16				227	282	338	395	446	11
17				256	320	385	446	504	14
18				287	359	432	499	564	3
19				320	400	480	555	629	6
20				354	442	530	614	693	3
21				388	486	582	675	760	1
22				424	530	637	739	829	1
23				461	577	695	803	899	
24				499	627	752	868	970	1
25				537	677	810	935	1,044	
26				576	727	870	1,001	1,116	1
27				618	780	932	1,068	1,190	2
Basis	4	28	51	49	45	50	14	6	247

⅛-inch saw kerf, 1-inch boards. Stump height 1 foot; top diameter inside bark 5 inches. Scaled in 16-foot log lengths, with 0.3-foot trimming allowances, and additional top section to a 5-inch top. Heavy rules indicate extent of basic data.

TABLE 6.—*Volume in board feet, International ⅛-inch rule, second-growth loblolly pine*—Continued

BY NUMBER OF 16-FOOT LOGS IN TREE

Diameter breast high, inches	Number of 16-foot logs						Basis, trees
	1¼	2	3	4	5	6	
	Volume in board feet						
7	18	28	43	58			35
8	20	34	55	77			52
9	22	42	68	97	124		30
10	24	48	83	118	155		17
11	26	56	98	142	187	230	21
12	28	63	113	167	219	272	10
13	30	72	130	194	255	317	16
14	32	81	149	222	292	363	14
15		90	168	251	333	414	9
16		98	189	282	375	468	11
17		108	210	213	418	524	14
18		120	233	347	464	583	3
19		131	256	382	511	643	6
20			279	419	562	705	3
21			304	458	614	770	1
22			331	500	669	839	1
23			357	542	725	907	
24			386	584	784	975	1
25				628	844	1,046	
26				674	906	1,119	1
27				720	969	1,190	2
Basis	30	77	48	53	35	4	247

⅛-inch saw kerf, 1-inch boards. Stump height 1 foot; top diameter inside bark 5 inches. Scaled in 16-foot log lengths, with 0.3-foot trimming allowances, and additional top section to a 5-inch top. Heavy rules indicate extent of basic data.

TABLE 7.—*Volume in board feet, Doyle rule, second-growth loblolly pine*

Diameter breast high, inches	Number of 16-foot logs						Basis, trees
	1¼	2	3	4	5	6	
	Volume in board feet						
9	13	22	33				12
10	17	27	43	63	80		17
11	20	33	54	78	101		21
12	23	39	67	97	125	155	10
13	27	46	80	116	151	187	16
14	30	53	93	137	178	222	14
15	34	60	108	158	208	260	9
16	38	67	124	182	241	301	11
17		74	141	208	275	343	14
18		82	158	235	313	390	3
19			178	265	353	440	6
20			198	296	398	493	3
21			222	330	444	548	1
22			245	365	492	607	1
23			270	402	540	669	
24			296	439	592	735	1
25			323	479	644	803	
26			352	521	698	874	1
27			380	565	754	949	2
Basis	17	34	26	54	11		142

Stump height 1 foot; top diameter inside bark 7 inches. Scaled in 16-foot log lengths, with 0.3-foot trimming allowance, and additional top section to a 7-inch top. Heavy rules indicate extent of basic data.

TABLE 8.—*Volume in cords of second-growth longleaf pine*

ROUGH WOOD

Diameter breast high, inches	Total height, in feet										Basis, trees
	20	30	40	50	60	70	80	90	100	110	
	Volume in cords										
4	0.00721	0.0107	0.0165	0.0220	0.0279						14
5	.00814	.0165	.0258	.0338	.0413	0.0492					69
6	.0123	.0238	.0365	.0490	.0595	.0702	0.0841	0.0960			95
7	.0164	.0320	.0485	.0665	.0830	.0960	.110	.125			88
8	.0210	.0410	.0618	.0865	.107	.126	.140	.158			89
9	.0264	.0509	.0760	.108	.133	.158	.178	.200			45
10			.0915	.129	.163	.194	.223	.247	0.278	0.303	35
11				.155	.196	.233	.270	.303	.339	.371	27
12				.181	.229	.275	.318	.357	.400	.439	11
13				.208	.263	.317	.366	.414	.463	.509	9
14				.238	.297	.359	.416	.472	.526	.579	5
15				.266	.331	.401	.465	.532	.592	.650	15
16				.295	.365	.445	.515	.590	.657	.723	9
17				.326	.400	.487	.567	.651	.722	.797	11
18				.358	.435	.532	.617	.711	.789	.869	1
Basis		10	78	118	127	84	73	27	6		523

PEELED WOOD

4	0.00476	0.00714	0.0118	0.0162	0.0212						14
5	.00568	.0118	.0194	.0255	.0317	0.0397					69
6	.00889	.0178	.0284	.0382	.0473	.0571	0.0640				95
7	.0122	.0245	.0380	.0525	.0667	.0788	.092	0.109			88
8		.0318	.0486	.0690	.0870	.105	.118	.138			89
9			.0602	.0870	.107	.130	.152	.173			45
10			.0734	.107	.134	.162	.189	.214	0.244	0.269	35
11				.127	.163	.196	.230	.262	.298	.328	27
12				.149	.192	.232	.272	.309	.351	.390	11
13				.172	.220	.268	.313	.358	.406	.452	9
14				.197	.250	.304	.357	.408	.463	.514	5
15				.221	.278	.340	.398	.458	.518	.576	15
16				.246	.308	.377	.442	.510	.574	.640	9
17				.272	.338	.413	.485	.560	.630	.704	11
18				.298	.367	.452	.529	.612	.688	.768	1
Basis		10	78	118	127	84	73	27	6		523

Volume includes stem above a 1-foot stump to a top diameter inside the bark of 3 inches. Heavy rules indicate extent of basic data.

TABLE 9.—*Volume in board feet, International ¼-inch rule, second-growth longleaf pine*

BY TOTAL HEIGHT OF TREE IN FEET

Diameter breast high, inches	Total height, in feet								Basis, trees
	40	50	60	70	80	90	100	110	
	Volume in board feet								
7	8	16	24	32	39				77
8	10	22	34	46	57				89
9	13	30	47	64	81	95			45
10	17	40	63	85	107	127	145		35
11			82	110	137	162	185		27
12			100	134	168	199	227		11
13			120	161	200	237	271		9
14			137	183	228	270	310	346	5
15			152	203	253	301	345	385	15
16			169	226	281	334	384	430	9
17			187	250	311	367	421	471	11
18			207	274	338	398	457	511	1
Basis	3	37	109	80	73	27	5		334

BY NUMBER OF 16-FOOT LOGS IN TREE

Diameter breast high, inches	Number of 16-foot logs						Basis, trees
	1¼	2	3	4	5	6	
	Volume in board feet						
7	19	29	44				77
8	21	37	59	82			89
9	23	45	75	106	137		45
10	26	53	91	129	168	210	35
11	29	61	107	154	201	248	27
12	32	69	124	180	235	291	11
13		78	140	207	270	336	9
14		86	158	234	306	382	5
15		94	177	263	345	432	15
16		103	197	293	387	484	9
17		112	218	324	431	539	11
18		121	239	356	475	595	1
Basis	46	134	86	60	8		334

¼-inch saw kerf, 1-inch boards. Stump height 1 foot; top diameter inside bark 5 inches. Scaled in 16-foot log lengths, with 0.3-foot trimming allowance, and additional top section to a 5-inch top. Heavy rules indicate extent of basic data.

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TABLE 10.—*Volume in board feet, Doyle rule, second-growth longleaf pine*

Diameter breast high, inches	Number of 16-foot logs					Basis, trees
	1¼	2	3	4	5	
	Volume in board feet					
9	13	23	35	47		32
10	15	29	47	65		33
11	16	35	59	83		27
12	17	41	71	102		11
13	19	47	84	122		9
14	20	54	98	143	187	5
15	22	60	112	164	217	15
16	23	67	127	188	250	9
17		74	144	214	284	11
18		83	160	240	323	1
Basis	17	62	45	26	3	153

Stump height 1 foot, top diameter inside bark 7 inches. Scaled in 16-foot log lengths, with 0.3-foot trimming allowance, and additional top section to a 7-inch top. Heavy rules indicate extent of basic data.

TABLE 11.—*Volume in cords of second-growth shortleaf pine*

ROUGH WOOD

Diameter breast high, inches	Total height, in feet									Basis, trees
	20	30	40	50	60	70	80	90	100	
	Volume in cords									
4	0.00974	0.0148	0.0196	0.0256	0.0295					7
5	.0148	.0229	.0306	.0390	.0465	0.0528				26
6	.0207	.0320	.0432	.0550	.0665	.0755	0.0850			43
7	.0275	.0424	.0575	.0733	.0890	.103	.114	0.125		40
8	.0350	.0540	.0745	.0950	.115	.133	.150	.163	0.176	34
9	.0440	.0665	.0924	.118	.143	.166	.190	.208	.225	26
10		.0810	.111	.143	.172	.203	.233	.256	.279	17
11			.131	.170	.206	.244	.280	.309	.337	19
12			.155	.200	.245	.289	.330	.367	.402	4
13			.179	.234	.285	.339	.388	.432	.475	4
14				.269	.329	.392	.449	.502	.552	9
15				.307	.374	.450	.515	.579	.635	21
16				.345	.424	.510	.585	.659	.725	9
17				.386	.476	.572	.660	.749	.821	11
18				.427	.530	.638	.738	.842	.921	6
19					.588	.708	.820	.940	1.03	4
20					.647	.781	.907	1.04	1.15	3
21						.860	.996	1.15	1.26	1
22						.939	1.09	1.26	1.39	
23						1.02	1.18	1.37	1.52	
24						1.10	1.29	1.48	1.65	
25						1.18	1.39	1.60	1.79	
26						1.27	1.50	1.72	1.94	1
Basis	1	22	44	49	53	54	35	21	6	285

Volume includes stem above a 1-foot stump to a top diameter inside the bark of 3 inches. Heavy rules indicate extent of basic data.

TABLE 11.—*Volume in cords of second-growth shortleaf pine*—Continued

PEELED WOOD

4	0.00750	0.0115	0.0158	0.0210	0.0259					7
5	.0115	.0179	.0249	.0324	.0398	.0466				26
6	.0162	.0252	.0352	.0455	.0559	.0670	.0772			43
7	.0216	.0335	.0470	.0598	.0750	.0912	.104	0.118		40
8	.0273	.0427	.0597	.0770	.0973	.117	.135	.154	0.174	34
9	.0334	.0527	.0741	.0967	.120	.146	.170	.195	.219	26
10		.0635	.0895	.118	.146	.179	.208	.239	.267	17
11			.105	.140	.174	.212	.249	.286	.319	19
12			.124	.163	.204	.250	.293	.340	.379	4
13			.143	.189	.237	.290	.341	.397	.444	4
14				.217	.271	.332	.392	.457	.515	9
15				.246	.309	.379	.448	.520	.590	21
16				.277	.349	.428	.505	.590	.666	9
17				.309	.390	.480	.566	.660	.749	11
18				.341	.432	.532	.630	.737	.839	6
19					.476	.589	.696	.816	.927	4
20					.521	.645	.767	.900	1.02	3
21						.703	.840	.986	1.12	1
22						.767	.915	1.07	1.23	
23						.829	.993	1.17	1.33	
24						.892	1.07	1.26	1.44	
25						.956	1.15	1.35	1.56	
26						1.02	1.23	1.45	1.68	1
Basis	1	22	44	49	53	54	35	21	6	285

Volume includes stem above a 1-foot stump to a top diameter inside the bark of 3 inches. Heavy rules indicate extent of basic data.

TABLE 12.—*Volume in board feet, International ⅛-inch rule, second-growth shortleaf pine*

BY TOTAL HEIGHT OF TREE IN FEET

Diameter breast high, inches	Total height, in feet								Basis, trees
	40	50	60	70	80	90	100	110	
	Volume in board feet								
7	14	18	24	30					30
8	18	26	38	50	64				33
9	22	37	53	73	95	118			26
10		50	72	97	125	154			17
11		66	93	123	154	187			19
12			115	148	183	219			4
13			140	177	216	255			4
14			162	205	249	292			9
15			184	234	284	334	383		21
16			210	267	324	380	436		9
17			233	299	364	429	493		11
18			254	331	407	483	558		6
19				365	453	541	627		4
20				411	506	599	690	780	3
21					560	664	767	870	1
22					620	736	849	960	
23					689	815	936	1,055	
24					753	891	1,025	1,155	
25					810	965	1,116	1,263	
26					870	1,044	1,212	1,378	1
Basis	4	32	45	55	35	21	6		198

⅛-inch saw kerf, 1-inch boards. Stump height 1 foot, top diameter inside bark 5 inches. Scaled in 16-foot log lengths, with 0.3-foot trimming allowance, and additional top section to a 5-inch top. Heavy rules indicate extent of basic data.

TABLE 12.—*Volume in board feet, International ⅛-inch rule, second-growth shortleaf pine*—Continued

BY NUMBER OF 16-FOOT LOGS IN TREE

Diameter breast high, inches	Number of 16-foot logs						Basis, trees
	1¼	2	3	4	5	6	
	Volume in board feet						
7	18	30	44				30
8	20	38	60	82			33
9	22	45	76	106			26
10	25	53	93	131	174		17
11	27	62	112	157	209		19
12	29	70	130	186	246		4
13	31	79	149	216	285		4
14	33	88	169	247	327		9
15	35	97	189	280	372		21
16		107	210	314	418	520	9
17		117	233	350	468	582	11
18		128	256	389	521	650	6
19		140	282	431	578	723	4
20		151	310	475	639	800	3
21			340	523	701	880	1
22			372	571	768	965	
23			405	622	838	1,054	
24			439	675	912	1,147	
25				729	989	1,243	
26				785	1,068	1,343	1
Basis	26	50	57	44	20	1	198

⅛-inch saw kerf, 1-inch boards. Stump height 1 foot, top diameter inside bark 5 inches. Scaled in 16-foot log lengths, with 0.3-foot trimming allowance, and additional top section to a 5-inch top. Heavy rules indicate extent of basic data.

TABLE 13.—*Volume in board feet, Doyle rule, second-growth shortleaf pine*

Diameter breast high, inches	Number of 16-foot logs						Basis, trees
	1¼	2	3	4	5	6	
	Volume in board feet						
9	12	24	42				19
10	13	29	50	73			17
11	14	34	60	86			19
12	16	38	70	103	135		4
13	18	45	83	122	161		4
14	20	53	98	144	191		9
15	22	62	115	171	227		21
16	24	71	135	199	264		9
17	26	81	156	232	307	384	11
18	28	91	178	265	354	443	6
19		103	201	301	402	503	4
20		115	225	338	452	568	3
21			252	378	505	634	1
22			279	419	561	704	
23			308	464	620	776	
24			338	513	690	861	
25			377	574	773	964	
26			422	642	867	1,085	1
Basis	12	28	44	32	12		128

Stump height 1 foot; top diameter inside bark 7 inches. Scaled in 16-foot log lengths, with 0.3 foot trimming allowance, and additional top section to a 7-inch top. Heavy rules indicate extent of basic data.

TABLE 14.—*Volume in cords of second-growth slash pine*

ROUGH WOOD

Diameter breast high, inches	Total height, in feet										Basis, trees
	20	30	40	50	60	70	80	90	100	110	
	Volume in cords										
4	0.00923	0.0148	0.0195	0.0265	0.0325	0.0389					8
5	.0118	.0185	.0272	.0367	.0470	.0572	0.0660				20
6	.0153	.0248	.0365	.0489	.0637	.0786	.0915	0.108			30
7	.0192	.0325	.0477	.0637	.0828	.103	.120	.141			42
8	.0234	.0417	.0602	.0802	.105	.132	.151	.177	0.200		19
9		.0525	.0742	.0998	.130	.161	.188	.217	.241	0.270	14
10			.0898	.121	.156	.194	.225	.260	.286	.324	24
11			.107	.145	.185	.228	.267	.308	.335	.383	19
12			.124	.170	.218	.263	.310	.358	.390	.444	23
13				.199	.250	.303	.360	.410	.450	.508	21
14				.229	.288	.347	.408	.465	.513	.573	14
15				.259	.325	.391	.459	.521	.578	.641	12
16				.290	.364	.438	.512	.580	.641	.715	14
17					.407	.487	.568	.643	.710	.790	5
18					.458	.538	.623	.708	.784	.868	2
19					.490	.590	.684	.777	.860	.948	1
20					.532	.645	.748	.845	.940	1.03	
21					.575	.700	.814	.918	1.02	1.11	1
Basis		9	28	42	42	25	50	65	8		269

PEELED WOOD

4	0.00595	0.00950	0.0132	0.0180	0.0225	0.0275					8
5	.00795	.0130	.0194	.0260	.0339	.0415	0.0489				20
6	.0106	.0178	.0268	.0358	.0471	.0583	.0685	0.0818			30
7	.0138	.0239	.0354	.0472	.0618	.0775	.0918	.108			42
8	.0174	.0312	.0454	.0607	.0798	.100	.118	.138	0.158		19
9		.0399	.0567	.0768	.101	.125	.148	.172	.192	0.215	14
10			.0690	.0942	.123	.152	.178	.206	.229	.257	24
11			.0835	.113	.146	.181	.213	.244	.270	.306	19
12			.0999	.133	.173	.212	.250	.285	.314	.358	23
13				.158	.201	.243	.288	.330	.364	.412	21
14				.183	.232	.278	.328	.375	.417	.468	14
15				.208	.264	.317	.372	.423	.472	.530	12
16				.235	.297	.357	.417	.474	.530	.591	14
17					.330	.398	.464	.526	.588	.655	5
18					.363	.440	.512	.582	.650	.735	2
19					.398	.483	.562	.639	.715	.787	1
20					.433	.528	.615	.697	.782	.856	
21					.470	.573	.672	.756	.852	.927	1
Basis		9	28	42	42	25	50	65	8		269

Volume includes stem above a 1-foot stump to a top diameter inside the bark of 3 inches. Heavy rules indicate extent of basic data.

TABLE 15.—*Volume in board feet, International ⅛-inch rule, second-growth slash pine*

BY TOTAL HEIGHT OF TREE IN FEET

Diameter breast high, inches	Total height, in feet							Basis, trees
	40	50	60	70	80	90	100	
	Volume in board feet							
7	10	14	19	26	34			33
8	16	23	32	42	53			19
9	24	34	46	59	74			14
10	30	46	61	77	98	116	136	27
11			76	97	122	145	172	19
12			93	118	147	176	206	23
13			110	140	173	207	244	21
14			128	162	199	239	280	13
15			145	184	226	272	320	13
16			163	205	253	303	380	14
17			180	227	280	336	400	5
18			198	250	307	368	438	2
19			216	272	334	400	476	1
20			234	294	361	432	514	
21			251	315	388	464	552	1
Basis	1	16	37	24	53	65	8	205

BY NUMBER OF 16-FOOT LOGS IN TREE

Diameter breast high, inches	Number of 16-foot logs					Basis, trees
	1¼	2	3	4	5	
	Volume in board feet					
7	20	30	46			33
8	22	37	57			18
9	25	43	70	97		14
10	28	49	84	117	153	27
11		56	97	138	183	19
12		63	112	161	212	23
13		69	127	188	244	21
14		77	142	207	276	14
15		84	158	233	311	12
16		92	177	259	347	14
17			195	288	285	5
18			213	317	424	2
19			234	348	466	1
20			255	381	511	
21			277	414	557	1
Basis	33	24	40	73	34	204

⅛-inch saw kerf, 1-inch boards. Stump height 1 foot, top diameter inside bark 5 inches. Scaled in 16-foot log lengths, with 0.3-foot trimming allowance, and additional top section to a 5-inch top. Heavy rules indicate extent of basic data.

TABLE 16.—*Volume in board feet, Doyle rule, second-growth slash pine*

Diameter breast high, inches	Number of 16-foot logs					Basis, trees
	1¼	2	3	4	5	
	Volume in board feet					
9	17	23	34	47	----	6
10	18	26	42	57	----	26
11	20	30	51	71	92	19
12	22	35	61	86	111	23
13	24	40	71	102	131	21
14	27	47	82	121	156	14
15	30	51	94	140	183	12
16	----	57	109	160	211	14
17	----	64	124	183	242	5
18	----	71	140	207	275	2
19	----	79	156	232	309	1
20	----	87	175	260	348	----
21	----	95	196	291	388	1
Basis	6	31	57	50	----	144

Stump height, 1 foot; top diameter inside bark, 7 inches. Scaled in 16-foot log lengths, with 0.3-foot trimming allowance, and additional top section to a 7-inch top. Heavy rules indicate extent of basic data.

YIELD TABLES

EXPLANATION OF TABLES

Tables 17, 19, 21, and 23, as indicated by the earlier definition of a yield table, show the volume in cords of wood (with and without bark) which is present at various ages on an acre of normal or fully stocked pine forest of each of the four species. Tables 18, 20, 22, and 24 give the same information in terms of board feet, both by the International rule and by the Doyle rule. Values in these tables are given for each of several sites. This term requires detailed explanation.

SITE

The quantity of wood which a measured area of ground, such as an acre, is able to produce is, of course, very greatly affected by the kind of soil and the climate of the region. This combination of soil and climate is conveniently described by the single word "site." It is plain that both soil and climate must be taken into consideration, since a rich soil may be offset by a cold or dry climate and a poor soil by a long growing season and abundant rainfall. Although the South as a whole has a climate very favorable to the growth of both forest and farm crops, because of a growing season six to nine months long and a rainfall of 40 to 60 inches yearly, there are important variations, particularly in temperature, in the 1,200 miles from Virginia to east Texas, also from the coastal plain, only a few feet above sea level, to the Ouachita Mountains of Arkansas and the piedmont plateau at 2,500 feet. Soils are also diverse.

A site class is a group of sites whose capacity to produce wood is the same within certain well-defined limits. The best and only final measure of this capacity and of its limits is the volume of wood actually produced on the site by a fully stocked stand. It is very hard, however, to measure with any accuracy the amount of wood

in a stand where the trees are very young, even regardless of stocking, and in most so-called natural stands, old or young, no measurable portion is fully stocked. In such stands and in overcrowded stands the volume of wood on a unit of area is no reliable index of the capacity of the site to produce. In judging site class it is therefore desirable to have some usable and convenient index besides the volume of a full stand of trees.

Much study here and abroad has shown that a generally reliable site index whereby any site may be recognized, is the height attained at some standard age by the average dominant [6] tree in an even-aged stand growing on that site. The height of dominant trees is not greatly affected by crowding or openness of the stand, except where these conditions are extreme. The standard age for the southern pines has arbitrarily been taken as 50 years, although 40 or 60 years would probably have served equally well.

Loblolly pine were found in the course of this study growing on sites so poor that the dominant trees averaged only 60 feet tall at 50 years, and on all qualities of site from that up to those where the dominant trees were 110 or even 120 feet tall at that age. By definition the first of these sites has a site index of 60 feet, and falls within the 60-foot site class; the site indices of the best stands are 110 or 120 feet, and they fall within the 110-foot and 120-foot site classes. For the other species the range of site classes encountered by the field crews in the present study was as follows: Longleaf, 40-foot to 110-foot; shortleaf, 40-foot to 100-foot; and slash, 60-foot to 100-foot.

Yields to be expected from each 10-foot site class are given separately in the tables. The 60-foot site class includes all sites having an index of 56 to 65 feet; the 70-foot, all those having an index of 66 to 75 feet, and so on.

EXPLANATION OF CORDWOOD TABLES

Such headings in the cordwood tables as require comment are explained as follows:

Age.—Age is the average number of years from seed attained by the trees in the stand. As earlier stated, the stands measured as a basis for the tables, and those to which the figures are intended to apply, are even aged, i. e., the trees are within 10 years, and generally within 5 years, of being the same age.

Total height, average dominant tree.—The average dominant tree is a tree of average diameter among the dominants. At 50 years, in the 60-foot site class this will by definition be a tree averaging 60 feet, regardless of species; but the heights of dominant trees at other than the reference age, or 50 years, differ as between species. At 20 years, on 60-foot sites, for example, the average dominant loblolly pine is 32 feet tall; longleaf, 31 feet; shortleaf, 30 feet; and slash, 36 feet. The total height of the average tree, including "all trees," as defined in the next paragraph, is generally 3 to 6 feet less than that of the average dominant.

[6] The dominant trees in an even-aged stand are those whose tops are in full light; that is, most of whose upper branches are not shaded by surrounding trees. They are the largest and most vigorous individuals, and include from 40 to 70 per cent of all the trees in the stand, depending on the age of the stand, how well it is stocked, the site, and other factors. Trees older than the average in even-aged stands, and therefore distinctly taller, are known as wolf trees and should not be classed as dominant trees.

All trees.—By all trees are meant those 1.6 inches or larger in diameter at breast height, regardless of whether they are dominant. Trees 1.6 inches d. b. h. are included at the lower limit of the 2-inch class. Trees smaller than this have a negligible volume.

Number per acre.—The number of living trees per acre. Dead trees, although standing, nowhere enter into the calculations.

Merchantable trees.—Since no trees smaller than 4 inches in diameter, breast high, are likely to be cut for cordwood or pulpwood, merchantable trees are defined as those 3.6 inches and larger.

Range.—In every natural even-aged stand of timber the range in diameters is greater than the range in height. This is due to the fact that, to remain alive at all, the trees must continue to keep their green leaves at a level where they will have light, whereas mere slenderness of trunk is no vital handicap. No diameter is here included at the upper limit of the range unless 5 per cent or more of the trees in the stand are of that size or larger; and at the lower limit, unless 5 per cent or more of the trees are smaller.[7] Since a merchantable tree is by definition at least 3.6 inches in diameter, the lower limit of range never falls below 4.

Average yearly growth per acre.—The average volume of wood grown in a year during the life of a stand. It is found by dividing the total yield by the age. This amount is not grown every year, for when the trees are small no wood of cordwood size is produced, and growth at all ages varies more or less from year to year with climatic conditions, particularly rainfall. However, average growth is a useful measure for comparing the wood production of stands allowed to reach different ages before cutting.

EXPLANATION OF BOARD-FOOT TABLES

The majority of the column headings will be clear from the explanation of similar headings in the cordwood-yield tables. A few differences occur, however. Trees as small as 6.6 inches at breast height are included among the 7-inch trees. No trees smaller than 6.6 inches are considered as having any board-foot volume under the International rule, nor are any smaller than 8.6 inches so considered under the Doyle rule. This corresponds to the 7-inch and 9-inch limits used in the board-foot volume tables by the International and Doyle rules. Board-foot yields are for the most part rounded to the nearest 500 feet, and always to the nearest 50 feet. Such rounding sometimes results in slight irregularities in the average yearly growth values. As explained on page 27 for a saw cutting a ¼-inch kerf, the yield and yearly growth figures by International rule must be reduced 9.5 per cent.

APPLICATION OF THE YIELD TABLES

The information contained in yield tables may be used for a variety of purposes. Its chief value is as a measure of the capacity of land to produce forest crops. It may also be used in predicting the future yields of existing stands, calculating fire damage (a special case of the preceding), and planning such operations as thinning and planting.

[7] Further details as to distribution of the trees by diameter classes are given later under the heading "Stand tables."

CALCULATION OF THE PRODUCING POWER OF LAND

A knowledge of how much timber his pineland is capable of growing in a given number of years is absolutely necessary to any landowner who wishes to put his property to the most profitable use over a period of time. The farmer, for example, confronted with the problem of whether to "take in" some of his woodland for farm crops, or leave it in trees, or even with the question of whether certain worn-out acres would not produce more if "thrown out" to come up to pine, is handicapped by lack of definite knowledge of the rate of tree growth. The large landowner can not estimate with certainty the investments which he may reasonably make in protecting his pineland against fire and in leaving seed trees to assure a second crop of timber, unless he has some such information on future timber crops as the yield tables afford. No enterprise, such as a pulp mill, sawmill, or large turpentine operation, which expects to obtain its raw material from second-growth pine, can justify a specified investment in land, manufacturing plant, or equipment intended for long use, without assurance that the timber will grow at definite rates. Figures of yield are, in short, indispensable to any wise use of land, or to the conduct of any long-term business dependent on the products of the forest.

In determining from the yield tables the productive capacity of any forest property in the piney woods of the South, there are four steps: (1) Identification and mapping of the sites; (2) choice of pine species adapted to each site; (3) decision as to the product to be raised—as cordwood, pulpwood, or saw logs, and if saw logs the desirable size; and (4) computation of growth, from the yield tables and information obtained from the property itself.

Identification and Mapping of Sites

WHEN SECOND GROWTH IS PRESENT

The importance of site may be judged from a comparison of the number of peeled cords produced in 20 years by loblolly pine on the best, or 120-foot site, with the number of cords produced in the same period on the lowest, or 60-foot site. From Table 17 it will be seen that the values are 35 cords against 10, or three and one-half times as much wood on the good site as on the poor. Thirty-five years of additional growth, or 55 years in all, would have to be made on the poor site to bring the yield to that at 20 years on the good site. Although the difference due to site tends to diminish slightly as the trees grow older, there are still over two and seven tenths times as many cords of peeled wood on the 120-foot as on the 60-foot site at 80 years.

The following procedure is suggested for deciding how many sites it is practicable to recognize and map in calculating the producing power of a given tract of land, loblolly pine being used for illustrative purposes.

Select two sites which are known to represent the extreme conditions, favorable and unfavorable, under which this pine grows naturally on the tract. These may be ridge tops at the one extreme, and hammock land, or fertile benches along small streams, at the other. Within each of these sites select one or more even-aged stands as nearly fully stocked as possible. The closer they are in age to 50 years (the index age) the better. Old-field stands should not be used in measuring the capacity of a site unless the entire site is also to be cultivated before trees are grown on it. Cultivation may

raise the quality of the site by one or two site classes for 10 or 20 years thereafter.

In each stand choose 10 to 20 trees which represent the dominant class; that is, trees whose tops form the general upper level of the forest foliage and have plenty of sunlight not only from above but for a little distance down the side. These should include not simply the largest but a good range of diameters within this class. Trees which stand or have recently stood in the open, as shown by limbs on the lower half of the trunk, and those which overtop the average of the leading trees as a whole, should be avoided. The height of the selected trees should then be measured to the nearest foot with any convenient instrument, such as the forester's hypsometer or grademeter,[8] and the age of each obtained from increment cores[9] bored at breast height.

Three years should be added to the ring count on cores taken at breast height, to allow for growth to that height. If the selected trees are felled heights may then be accurately measured from ground level to the extreme tip and the rings on the stump accurately counted. Two years[10] should be added to the stump count to allow for growth to a 1 or 2 foot height. In each stand the age of the selected trees and their heights should then be averaged.

The height of the average dominant tree in a stand being known, the next step is to refer the stand to a site as defined in the tables. If the age of all stands were exactly 50 years, the site-index age, this would be very easy. The stand with an average dominant height of between 56 and 65 feet would then plainly be on a 60-foot site; that with an average dominant height of between 86 and 95 feet on a 90-foot site; and so on. But if the age of a stand, as obtained by averaging the ages of the dominant trees, is not precisely 50, its site must be determined from column 2 of the yield tables. This column in the yield table for any site gives the height which the average dominant on that site reaches at ages both above and below 50. Suppose the age of a stand on the ridge, known to be a poor site, is 33 and its average dominant measures 57 feet. For all purposes other than scientific work this stand may be called 35 years old. Column 2 of either loblolly pine yield table for the 60-foot site class shows that the average dominant tree on this site is 50 feet tall at 35 years; the same column of the table for the 70-foot site class shows that its average dominant is 58 feet tall at this age. Since the dominant in the stand is only a foot shorter than the 35-year-old tree on the 70-foot site class in the table, and since its actual age is two years less, it is safe to identify the stand as growing on a 70-foot site.

Another stand measured on the poor site may be 62 years old and have an average dominant of 74 feet. Calling this 60 years old, and again referring to column 2 for the various sites, one finds that the average dominant at 60 years on a 60-foot site is 64 feet tall; and on a 70-foot site, 75 feet. Then this stand with its 74-foot dominant also belongs to the 70-foot site. The third stand on the poor site may

[8] Hypsometers are of several types. Probably the commonest is known as the Faustmann hypsometer, which is obtainable for about $35 from makers of scientific instruments. A simpler mechanism, the Forest Service grademeter, costs about $25, and is similarly obtainable.

[9] These are cores of wood, with approximately a 1/16-inch diameter, removed from the tree with a hollow auger of special design. The augers are called Pressler increment borers and are sold at $10 to $20, depending on their length, by makers of scientific instruments. If properly bored, the cores extend from the outside of the tree to the pith, and the number of rings of growth, corresponding to the tree's age at that point, may be counted.

[10] Three years to breast height, and two to stump height, will hold for all species except longleaf; because of very slow early growth, longleaf requires seven and five years, respectively, to reach these heights.

be identified similarly, but perhaps falls in the 80-foot site class. Since two out of the three stands belong to the 70-foot site, however, 70 feet may be taken as the average for the three, and as representative of the poorest sites on the tract as a whole. The stands on the hammocks, known to be the best sites, and the intermediate slopes between them and the ridges, may then be similarly examined, and the site determined for each. Assume these to be 90-foot and 80-foot sites, respectively.

There then remains the mapping of the various sites thus identified, or at least the estimation of their acreage. Any method familiar to land surveyors or timber cruisers may be used. The boundaries of the three sites will be judged by the topography, or lay of the land, and by the vigor and thrift of the timber where present.

As a practical matter it is doubtful whether more than three sites are likely to prove worth identifying on most pine tracts. Sites merge gradually into each other, and the process of sampling them by means of the dominant tree heights consumes both time and money. Hills and ridges, lower slopes, crawfish flats, hammock lands, and old fields, for example, are well known to anyone in the southern piney woods. They can be conveniently recognized and mapped when finer distinctions, based on tree heights, would be hard to draw.

In most parts of the pine belt it is very much more important to eliminate from consideration areas which will not come up to pine than to recognize hair-splitting differences of site. Meadows, savannas, baygalls, pure hardwood bottoms, glades, and many other locally named sites will be recognized as holding out little hope of producing pine. Classifying these areas as pineland, even of the poorest site quality shown in the tables, will produce an error many times as great as that involved in identifying a site as one 10-foot site class lower or higher than it merits. Yet they may amount to a considerable percentage of a tract which is commonly thought of as pure pineland.

WHEN SECOND GROWTH IS LACKING

In any region where loblolly, shortleaf, or slash pines have been at all common in the original forest, second growth of those species will rarely be lacking, and there will be little difficulty in identifying sites from the height of dominant trees. However, owing chiefly to widespread and severe yearly burning, longleaf lands are often wholly lacking in second-growth stands. Present knowledge does not permit of positive statements as to the use of trees from virgin stands as a substitute, but pending further study the following procedure is suggested:

Select for measurement of height and age a dozen or more trees on each site which it appears feasible to map. These trees should be selected because they stand in openings where conditions for their growth were similar to those in second-growth stands; that is, where competition for soil moisture and light with older well-established trees was largely lacking. In judging that a tree is open grown, it is necessary to consider not only adjacent trees now standing, but those which may have been standing when it was young. Stumps,

"clay roots" (earth mounds formed by soil washed from the roots of trees uprooted by wind), and dead stubs represent trees which in times past may have overshadowed or competed for soil moisture with the measured tree. To be sure that there has been no such shading or severe competition below ground it is desirable to examine the growth rings, either on increment cores, or if the tree is felled for this purpose, on the stump. Wide rings, as compared with those of average virgin trees, or smaller rings that show no sudden increase in width such as results when a tree is freed from the shade or root competition of older trees surrounding it, indicate a growth similar to that in second-growth stands. A virgin tree with such rings is probably only a little shorter than a dominant tree in a second-growth stand.

The several trees of this character which have thus been selected and measured for height will be likely to differ considerably in age. The method of referring each to a site is exactly parallel to that of referring an even-aged stand to its site from the height and age of the average dominant tree in it. There will be apt to be a wider variation in site index as found from single trees in virgin stands than from average dominants in even-aged second-growth stands, but an average must be struck in both estimates. If neither second-growth trees nor open-grown trees of the virgin stand are present, determination of site becomes a matter of speculation only, although studies are now directed toward finding means to use the height of virgin trees other than the selected, open-grown individuals just described.

Choice of Pine Species Adapted to Each Site

In the southern pine woods probably the best guide to the kind of pine adapted to growth on a particular site is the original forest. If loblolly pine grew there originally, loblolly pine can reasonably be counted upon to thrive there again; if longleaf, longleaf should do well in the next generation. Only occasionally is there justification in departing from a plan which has been worked out by natural forces over many centuries. An example of such departure might be the planting of quick-growing loblolly pine for pulpwood on an abandoned hilltop field originally in shortleaf. On such situations the loblolly will generally make better growth than shortleaf for 15 or 20 years, or until the improvement in soil conditions caused by cultivation has largely disappeared. For saw-log production, requiring two or three times as long as pulpwood production, the loblolly would prove a poor substitute for the original shortleaf on this naturally dry site.

Where more than one kind of pine has grown in the original forest, as for example shortleaf and loblolly pines in mixture, the site may be identified from dominant tree heights of each species separately and a choice made of the kind which promises to produce the most valuable product in the shortest time.

Decision as to the Product to be Raised

The nature and average size of the forest product to be grown are dictated largely by the business situation of the individual landowner. The landowner who does not cut his timber for his own manufacturing plant, but who may convert it into any product that commands a market, will do well to balance the net returns from one product

against another, each requiring a certain time to mature, and grow his trees to the age thus shown to be the most profitable. (Fig. 10.)

Computation of Growth

small tracts

Knowing the acreage he has of each site class that it is practicable to recognize, being sure of the kind of pine which will flourish there, and having in mind the markets for the various forms into which the wood may be grown, the landowner is in a position to calculate from the yield tables the productive capacity of his land. This is not a complicated or difficult process, as may best be shown by an example drawn from loblolly pine.

F–203940

Figure 10.—In this tram-tie operation in second-growth loblolly and shortleaf pine in Louisiana the trees up to 10 inches are being hacked for ties; those over 10 inches will be cut into saw logs

Assume that the landowner is a farmer with 40 acres of woodland in a community where pine logs have a ready sale to near-by sawmills, but where the only demand for cordwood is for domestic purposes on the farm itself. Of the 40 acres about 5 are in an overflow bottom which never grew loblolly pine, 15 acres are on hilltops and ridges, 10 are in a good hammock, and the remaining 10 acres are on the hillsides between ridge and hammock. The ridges turn out to be 60-foot site class, the hillsides 70-foot site class, and the hammocks a good 90-foot site class. How much pine is the whole woodland capable of growing each year?

Saw logs being the only salable product at present, the yield of pine is best calculated in board feet, by the International rule, from Table 18.

From the yield per acre column for the 60-foot site class it is evident that no saw logs are produced on such a site in less than 25 years, but that increasing volumes will mature at successive ages beyond that age. The question at once arises, should the landowner count on cutting over his 15 acres of 60-foot site (ridges) whenever the timber reaches 25 years or can he get a greater average yearly yield, or crop, by allowing the timber to grow older than that before being cut? The answer is found in the average yearly growth column of the same table, which shows that an average growth each year of only 80 board feet an acre has taken place in a 25-year-old stand, whereas in one 55 years old the average yearly growth has been 318 board feet an acre. After that age the growth slows up, although very gradually. Three hundred and eighteen board feet an acre a year is then the most the owner can expect from his ridge acres; or, since he has 15, a total of 4,770 board feet a year.

The hammock land tells a different story. Its 90-foot site will grow a few saw logs in as short a time as 20 years, and reference to column 9 of the 90-foot table shows that at 50 years its average yearly growth, 750 board feet, is higher than at any other age. The 10 acres of hammock land can then grow 7,500 board feet yearly. A similar calculation for the 10 acres of hillsides, or 70-foot sites, shows that they can grow a maximum of 4,450 board feet a year over a period of 55 years.

The summary is then as follows:

15 acres, hilltop and ridge (site 60)	board feet	4, 770
10 acres, hammock land (site 70)	do	4, 450
10 acres, hillside (site 90)	do	7, 500
Total yield, all sites	do	16, 720

The producing power of this 40-acre woodland is therefore 16,720 board feet of loblolly saw logs a year. The 5 acres of hardwoods would of course swell the total production.

It should be at once pointed out that average yearly growth is used in the above illustration simply as a measure of the productive capacity of the farm woodland in question. As small a quantity of saw logs as is represented in 16,720 board feet might, of course, be cut each year by a resident farmer for a steady market, but it is more probable that he would cut less often, and on a larger scale when he did. Certainly he could not well cut one-fiftieth of his 10 acres of hammock land and one fifty-fifth of his 15 acres of ridge tops and 10 acres of hillsides, every year, which is what the theoretical calculation given in Table 17 requires. In fact it is doubtful whether a well-managed farm woodland of this size would continue to be kept in even-aged stands at all. Very likely it would gradually be converted by careful cutting of only the largest, choicest trees to an all-aged forest which, barring hurricanes, worm deadenings, and destructive fires, the southern pine forests tend to be. Just what the yield per acre would be from an all-aged forest has not yet been investigated, but there is no reason to believe that it would differ greatly from that of an even-aged forest.

The 16,720 board feet of loblolly pine represents the growth which, according to the tables, these 35 acres can produce under better than the average of present natural conditions. If the landowner can not afford to allow his timber to reach ages of 50 to 55 years, the yearly

growth will average considerably less—for example, only 7,400 board feet of a much poorer grade, if the stands were all cut at 25 years of age. Another factor strongly influencing the age to which the trees may be allowed to grow, and the consequent average yearly growth, is the net returns. Calculation of these not only involves matters such as interest rates on the investment, taxes, and perhaps other charges on the one hand, and stumpage rates on the other, but also the individual circumstances of the landowner, such as the credit and interest rates he can command. All of these are so far beyond the scope of the present circular that they can not be considered here. It is well to repeat, as offsetting the likelihood of forced cutting at less than the most productive age, that stands which under favorable natural conditions yield the volumes given in the tables can with thinnings, or other human aid be made to produce not only material of a higher grade, but possibly more material than under natural conditions.

LARGE TRACTS

The calculation of the producing power of larger tracts will follow the same lines as the foregoing. It is well, however, to safeguard figures of yield more carefully, here, because of the difficulty of preventing fires in tracts larger than farm woodlands, or of attaining uniformly good distribution of seed over wide areas. To allow for the effect of occasional fires and lack of seed, discounts from the yield-table values of 10 or 20 per cent will no doubt be made by conservative owners of large tracts. This is in spite of the fact that the stands which were measured as a basis for the tables were by no means wholly free of fire injury beyond the sapling stage. It is believed that discounting the tabular yields is the preferable way to safeguard all calculations based on the yield tables; deliberate underrating of site qualities in order to be conservative may lead to serious errors.

It should be clearly understood that anything short of first-class fire protection may result in reductions in yield greater than these percentages. It is beyond the province of this bulletin to describe what first-class fire protection consists in, and in fact this will vary from region to region and tract to tract. But protection which limits the area burned yearly to 1 per cent of young stands and to 3 per cent of a property as a whole, comes up to the desirable standard, and is believed attainable for southern pine tracts of several thousand acres.

PREDICTION OF FUTURE YIELDS FROM EXISTING STANDS

Normal or Fully Stocked Stands

Present knowledge does not permit the tables to be very exactly used in predicting future yields from existing stands, unless such stands appear to be fully stocked. Where a stand is fully stocked, the yield up to 20 years in the future may be predicted with fair assurance simply by identifying the site, adding the specified period to the present age, and referring to the tables for that site to obtain the yield at the resulting age. There is no reason to believe that a stand now normally stocked will become seriously abnormal within as short a time as 20 years. This is of course leaving out of account severe injury of any kind.

At the present time the only reliable basis on which to judge whether the stand is normal is volume. That is, if a stand has a volume corresponding to the volume for the same age and site in the yield tables, it may be assumed to be normally stocked. Neither the completeness of the stand, judged by the space between the crowns of the trees; nor the number of trees, total number or dominant trees only; nor any other measure easy to obtain, has as yet been found to be a satisfactory substitute for volume in this connection. However, the matter is one which is still being investigated, and will continue to be as long as any hope remains of developing a short-cut method.

A study was made of a small number of plainly understocked loblolly stands in an effort to establish discounts from the yield-table volumes. It was hoped that the percentage relationship between the total number of trees in such stands and the number of trees in normal stands as represented by the tables might indicate a corresponding relationship in volume, but the discounts were unfortunately so erratic that no conclusions could be drawn. The comparative number of dominant trees is little if any better as an index of percentage of volume, as far as present experience goes; no doubt the difficulty of judging consistently which trees are dominant is at the bottom of this.

Stands Not Normally Stocked

A stand now understocked or overstocked, and therefore abnormal in volume, is believed to tend toward normality with increasing age. Studies of the rate of progress toward normality have thus far yielded scarcely any data. For the present the only course to pursue in predicting future yields from a stand now understocked is the conservative one of assuming that no change in percentage of stocking will take place. That is, if to-day's measurement of volume shows from the tables that a stand is half stocked, the future yield should be calculated as half that given in the tables for the new age. In this instance also 20 years should be the limit for prediction.

CALCULATION OF FIRE DAMAGE

The calculation of fire damage is merely a special case of the preceding two uses of the tables, but it is mentioned because fire-damage appraisal is likely to be of considerable importance henceforth in the South. Of the two standard methods of calculating the damage when a fire has partially or completely destroyed a stand, that which discounts future values involves the prediction of yield.

If a stand is young—say, up to 10 years for such rapidly growing species as loblolly or slash pine—the measure of damage when it is destroyed by fire is commonly regarded as the cost of restoring it, naturally or artificially, and protecting it to the same age, both items bearing compound interest. When an older stand is partially or completely destroyed, however, the measure of damage is usually considered to be the difference between the value of the stand at maturity, had it remained uninjured, and the value of the injured stand at maturity or, rather, this difference discounted back to the time of calculation. To measure this difference, it is of course necessary to know the percentage of stocking before the fire and the per-

centage after it, and to predict the yield at maturity in each case, as just described. Here again such steps as choosing an age of maturity, valuing the yield calculated for that age, deducting the cost of protection, and discounting to the present are beyond the province of this circular, but are described in standard works on forest valuation.

It should be pointed out that the method of prediction just described when applied to calculation of fire damage is no longer conservative, but gives the maximum damage. That is, a stand reduced in stocking by fire is assumed to make no progress with time toward normal yield. This is reasonable since rot, entering the trees through fire scars, may more than offset any apparent progress.

FIGURE 11.—Thinning to stimulate growth in this 22-year-old slash pine stand in Georgia has systematically released the leading trees, averaging about 7 inches in diameter breast high, from the competition of their less thrifty neighbors

YIELD TABLES AS A GUIDE IN THINNING

The object of thinning an overstocked stand is to so reduce the stand that the volume growth will be concentrated on a comparatively small number of better trees and so produce the greatest volume of useful material in a given time. The theory and practice of thinnings, only briefly touched upon here, are discussed at some length in other publications (*1, 2, 6, 8, 12, 13*).

The commonest method of thinning removes from a stand the weaker trees which in the interval before the next thinning will either die outright or will grow very slowly. Such slow-growing trees are not worth the soil moisture and light which they use, and of which they rob their more vigorously growing neighbors, the dominant trees.

It is believed that thinning of southern pine stands should be begun when the trees are from 10 to 20 years old, although market conditions may not allow this. The desirable interval between thinnings is probably 5 or 10 years. If a stand is thinned to the number of dominant trees which, according to the third column of Tables 18, 20, 22, and 24, grow in a normal stand on that site at an age about 10 years beyond the present, improved growth should result. (Fig. 11.) The thinning should not be done mechanically, however, since conditions on the ground will always outweigh any theoretical considerations. Moreover, since the tables are based on natural stands which have never had the benefit of thinnings, they do not themselves present ideal figures.

LIMITATIONS OF THE YIELD TABLES

Yield tables should never be used as a substitute for an actual cruise in estimating the yield of any particular tract. That is, merely identifying and measuring the area of the sites comprising it will not be a sound basis for calculating from the tables the amount of timber now present, or the yield several years hence. There is too great a variation possible in stocking to permit the use of any such crude method as this. The tables show the yields which the land is capable of producing, not what it has produced as a result of past conditions that differ from tract to tract. Measurement of what is actually on the ground is necessary in specific instances.

Predictions from the yield tables for any stands, and particularly for abnormally stocked stands, should be checked by other methods whenever possible. Chief among these methods is the study of rate of growth of individual trees, which can not be described here but will be found in any standard textbook on forest mensuration; the main difficulty in applying it is the lack of reliable information on how many and which trees will die during the period covered by the prediction.

The usefulness of the yield tables for ordinary purposes appears to have no important regional limitations. That is, provided a site has been correctly identified, it is unlikely that its location in Virginia, as opposed to its location in Arkansas, affects its yield appreciably. The regional yield tables are therefore expected to be equally usable throughout the southern pine region. The preparation and use of local yield tables will therefore rarely be necessary.

TABLE 17.—*Normal yield, in cords, second-growth loblolly pine*

Age (years)	Total height, average dominant tree	All trees		Merchantable trees			Yield per acre		Average yearly growth per acre	
		Stand per acre	D. b. h. of average tree	Stand per acre	Diameter		Rough wood	Peeled wood	Rough wood	Peeled wood
					Average	Range				
	Feet	*Number*	*Inches*	*Number*	*Inches*	*Inches*	*Cords*	*Cords*	*Cords*	*Cords*
60-FOOT SITE										
15	24	2,440	2.8	545	4.6	4	8	5	0.53	0.33
20	32	1,600	3.6	670	4.9	4	12	10	.60	.50
25	39	1,080	4.6	670	5.4	4–7	19	15	.76	.60
30	45	850	5.4	650	5.9	4–8	25	20	.83	.67
35	50	695	6.1	605	6.5	4–9	30	24	.86	.69
40	54	585	6.8	545	7.0	4–10	35	28	.88	.70
45	57	500	7.4	480	7.5	4–11	39	32	.87	.71
50	60	440	7.9	430	8.0	4–11	41	34	.82	.68
55	62	395	8.4	390	8.5	4–12	44	36	.80	.65
60	64	360	8.9	360	8.9	4–13	46	38	.77	.63
65	66	330	9.3	330	9.3	4–13	48	40	.74	.62
70	67	310	9.7	310	9.7	4–14	49	41	.70	.59
75	68	290	10.1	290	10.1	5–14	50	42	.67	.56
80	69	275	10.4	275	10.4	5–15	51	43	.64	.54
70-FOOT SITE										
15	29	1,840	3.3	580	4.8	4	12	8	0.80	0.53
20	38	1,185	4.3	675	5.2	4–7	17	13	.85	.65
25	45	810	5.5	630	6.0	4–8	24	19	.96	.76
30	52	640	6.5	575	6.8	4–9	31	25	1.03	.83
35	58	525	7.4	505	7.5	4–11	37	31	1.06	.89
40	63	435	8.1	430	8.2	4–12	42	36	1.05	.90
45	67	370	8.8	370	8.8	4–13	47	39	1.04	.87
50	70	325	9.4	325	9.4	4–13	50	42	1.00	.84
55	73	295	10.0	295	10.0	5–14	53	44	.96	.80
60	75	270	10.6	270	10.6	5–15	55	46	.92	.77
65	76	245	11.1	245	11.1	5–15	57	48	.88	.74
70	78	230	11.5	230	11.5	6–16	59	50	.84	.71
75	79	215	11.9	215	11.9	6–16	61	51	.81	.68
80	80	205	12.3	205	12.3	6–17	62	52	.78	.65
80-FOOT SITE										
15	33	1,430	3.7	635	4.9	4	14	10	0.93	0.67
20	43	950	5.0	665	5.6	4–8	22	17	1.10	.85
25	51	650	6.3	575	6.6	4–9	30	24	1.20	.96
30	59	510	7.4	490	7.5	4–11	38	31	1.27	1.03
35	66	415	8.4	410	8.4	4–12	45	38	1.29	1.09
40	72	345	9.2	345	9.2	4–13	51	43	1.28	1.08
45	76	295	10.0	295	10.0	5–14	56	48	1.24	1.07
50	80	255	10.7	255	10.7	5–15	60	51	1.20	1.02
55	83	230	11.4	230	11.4	5–16	63	54	1.15	.98
60	85	210	12.0	210	12.0	6–17	66	56	1.10	.93
65	87	195	12.6	195	12.6	6–17	68	58	1.05	.89
70	89	185	13.1	180	13.1	7–18	70	60	1.00	.86
75	90	170	13.6	170	13.6	7–18	71	61	.95	.81
80	92	160	14.0	160	14.0	7–19	73	62	.91	.78
90-FOOT SITE										
15	37	1,210	4.2	640	5.1	4–6	18	13	1.20	0.87
20	48	790	5.6	630	6.1	4–8	27	21	1.35	1.05
25	58	540	7.0	510	7.2	4–10	37	30	1.48	1.20
30	67	420	8.2	415	8.2	4–12	46	38	1.53	1.27
35	74	345	9.3	345	9.3	4–13	54	45	1.54	1.29
40	81	290	10.2	290	10.2	5–14	61	51	1.52	1.28
45	86	250	11.1	250	11.1	5–15	67	57	1.49	1.27
50	90	220	12.0	220	12.0	6–17	71	61	1.42	1.22
55	93	195	12.7	195	12.7	6–17	75	64	1.36	1.16
60	96	180	13.4	175	13.4	7–18	78	67	1.30	1.12
65	98	160	14.0	160	14.0	7–19	80	69	1.23	1.06
70	100	150	14.6	150	14.6	8–20	82	71	1.17	1.01
75	102	140	15.1	140	15.1	8–20	84	72	1.12	.96
80	103	135	15.6	130	15.6	9–21	85	74	1.06	.92

TABLE 17.—*Normal yield, in cords, second-growth loblolly pine*—Continued

100-FOOT SITE

Age (years)	Total height, average dominant tree	All trees		Merchantable trees			Yield per acre		Average yearly growth per acre	
		Stand per acre	D. b. h. of average tree	Stand per acre	Diameter		Rough wood	Peeled wood	Rough wood	Peeled wood
					Average	Range				
	Feet	*Number*	*Inches*	*Number*	*Inches*	*Inches*	*Cords*	*Cords*	*Cords*	*Cords*
15	41	1,040	4.5	640	5.4	4–7	21	16	1.40	1.07
20	54	690	6.1	595	6.5	4–9	32	26	1.60	1.30
25	64	480	7.6	465	7.7	4–11	43	35	1.72	1.40
30	74	375	9.0	370	9.0	4–13	53	45	1.77	1.50
35	83	300	10.2	305	10.2	5–14	63	54	1.80	1.54
40	90	255	11.2	255	11.2	5–16	71	61	1.78	1.52
45	95	215	12.2	220	12.2	6–17	78	67	1.73	1.49
50	100	190	13.1	195	13.1	7–18	84	72	1.68	1.44
55	104	170	13.9	175	13.9	7–19	88	76	1.60	1.38
60	107	155	14.6	155	14.6	8–20	92	79	1.53	1.32
65	109	145	15.3	145	15.3	8–20	94	81	1.45	1.25
70	112	135	15.9	135	15.9	9–21	96	83	1.37	1.19
75	113	125	16.5	125	16.5	10–22	98	85	1.31	1.13
80	115	115	17.1	115	17.1	10–23	100	87	1.25	1.09

110-FOOT SITE

15	45	930	4.9	640	5.6	4–7	24	19	1.60	1.27
20	59	615	6.6	560	6.9	4–10	37	30	1.85	1.50
25	70	435	8.2	430	8.3	4–12	50	41	2.00	1.64
30	81	335	9.7	335	9.7	4–14	62	52	2.07	1.73
35	91	270	11.0	270	11.0	5–15	73	62	2.09	1.77
40	99	225	12.1	225	12.1	6–17	82	71	2.05	1.78
45	105	195	13.1	195	13.1	7–18	90	78	2.00	1.73
50	110	170	14.1	170	14.1	8–19	96	84	1.92	1.68
55	114	155	15.0	155	15.0	8–20	101	88	1.84	1.60
60	118	140	15.9	140	15.9	9–21	106	92	1.77	1.53
65	120	125	16.6	130	16.6	10–22	109	95	1.68	1.46
70	122	120	17.3	120	17.3	10–23	112	98	1.60	1.40
75	124	110	17.9	110	17.9	11–23	114	100	1.52	1.33
80	126	105	18.4	105	18.4	11–24	116	102	1.45	1.28

120-FOOT SITE

15	49	850	5.3	640	5.8	4–8	30	23	2.00	1.53
20	64	560	7.1	535	7.3	4–10	42	35	2.10	1.75
25	77	395	8.8	395	8.8	4–13	57	48	2.28	1.92
30	89	305	10.4	305	10.4	5–15	70	61	2.33	2.03
35	99	245	11.8	245	11.8	6–16	83	72	2.37	2.06
40	108	205	13.0	205	13.0	7–18	93	82	2.32	2.05
45	114	175	14.1	175	14.1	8–19	102	90	2.27	2.00
50	120	155	15.1	155	15.1	8–20	110	97	2.20	1.94
55	125	140	16.1	140	16.1	9–21	116	102	2.11	1.85
60	128	125	17.0	125	17.0	10–22	121	106	2.02	1.77
65	131	115	17.8	115	17.8	11–23	125	110	1.92	1.69
70	133	105	18.5	105	18.5	11–24	128	113	1.83	1.61
75	136	100	19.2	100	19.2	12–25	131	116	1.75	1.55
80	137	95	19.7	95	19.7	12–26	134	118	1.68	1.48

TABLE 18.—*Normal yield, in board feet, second-growth loblolly pine*

60-FOOT SITE

Age (years)	Dominant trees		Trees 7 inches d. b. h. and larger			Yield per acre		Average yearly growth per acre	
	Total height, average tree	Stand per acre	Stand per acre	Diameter		International ¼-inch rule	Doyle rule	International ¼-inch rule	Doyle rule
				Average	Range				
	Feet	*Number*	*Number*	*Inches*	*Inches*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
15	24	955							
20	32	670	30	7.2	7				
25	39	480	100	7.5	7	2,000		80	
30	45	390	170	7.8	7–8	4,500		150	
35	50	330	225	8.1	7–9	7,000	500	200	14
40	54	290	265	8.4	7–10	10,000	1,000	250	25
45	57	255	280	8.8	7–11	12,500	2,000	278	44
50	60	230	280	9.1	7–11	15,000	3,000	300	60
55	62	215	280	9.5	7–12	17,500	4,000	318	73
60	64	200	270	9.8	7–13	19,000	5,000	317	83
65	66	185	260	10.1	7–13	20,500	6,000	315	92
70	67	175	250	10.4	7–14	22,000	7,000	314	100
75	68	170	245	10.7	7–14	23,000	8,000	307	107
80	69	160	235	11.0	7–15	24,000	8,500	300	106

70-FOOT SITE

15	29	735	20	7.0	7	50		3	
20	38	510	85	7.4	7	1,500		75	
25	45	385	180	7.8	7–8	4,500		180	
30	52	315	255	8.3	7–9	8,500	1,000	283	33
35	58	270	295	8.7	7–11	12,500	2,000	357	57
40	63	230	290	9.2	7–12	16,000	3,500	400	88
45	67	205	280	9.7	7–13	19,500	5,000	433	111
50	70	180	260	10.2	7–13	22,000	6,500	440	130
55	73	170	245	10.6	7–14	24,500	8,000	445	145
60	75	160	230	11.1	7–15	26,500	10,000	442	167
65	76	150	220	11.5	7–15	28,500	11,500	438	177
70	78	140	210	11.9	7–16	29,500	12,500	421	179
75	79	135	200	12.3	7–16	31,000	14,000	413	187
80	80	130	190	12.6	7–17	32,000	15,000	400	188

80-FOOT SITE

15	33	610	30	7.2	7	150		10	
20	43	430	135	7.6	7–8	3,000		150	
25	51	325	235	8.2	7–9	7,500	1,000	300	40
30	59	260	285	8.8	7–11	12,500	2,000	417	67
35	66	220	300	9.4	7–12	17,500	4,000	500	114
40	72	195	270	10.0	7–13	22,000	6,000	550	150
45	76	170	245	10.6	7–14	26,000	8,500	578	189
50	80	155	225	11.3	7–15	29,500	11,500	590	230
55	83	140	205	11.9	7–16	32,500	14,000	591	255
60	85	130	195	12.4	7–17	34,500	16,000	575	267
65	87	125	180	12.9	7–17	36,500	17,500	562	269
70	89	115	170	13.4	7–18	38,000	19,500	543	279
75	90	110	165	13.8	7–18	39,500	20,500	527	273
80	92	105	155	14.1	7–19	40,500	22,000	506	275

90-FOOT SITE

15	37	520	55	7.3	7	850		57	
20	48	370	190	7.8	7–8	5,000		250	
25	58	275	265	8.5	7–10	11,000	1,500	440	60
30	67	225	285	9.3	7–12	17,000	4,000	567	133
35	74	190	275	10.0	7–13	23,000	7,000	657	200
40	81	170	245	10.8	7–14	28,500	10,000	712	250
45	86	150	225	11.5	7–15	33,500	13,500	744	300
50	90	135	200	12.3	7–17	37,500	16,500	750	330
55	93	125	185	13.0	7–17	40,500	19,500	736	355
60	96	115	170	13.7	7–18	43,000	22,000	717	367
65	98	110	160	14.3	7–19	45,000	24,500	692	377
70	100	100	150	14.8	8–20	47,000	26,000	671	371
75	102	95	140	15.3	8–20	48,500	27,500	647	367
80	103	95	130	15.7	9–21	50,000	29,000	625	362

TABLE 18.—*Normal yield, in board feet, second-growth loblolly pine*—Continued

100-FOOT SITE

Age (years)]	Dominant trees		Trees 7 inches d. b. h. and larger			Yield per acre		Average yearly growth per acre	
	Total height, average tree	Stand per acre	Stand per acre	Diameter		International ¼-inch rule	Doyle rule	International ¼-inch rule	Doyle rule
				Average	Range				
	Feet	*Number*	*Number*	*Inches*	*Inches*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
15	41	470	85	7.5	7	1,800		120	
20	54	330	220	8.1	7–9	7,500	500	375	25
25	64	255	285	8.9	7–11	14,500	2,500	580	100
30	74	205	285	9.8	7–13	22,000	6,000	733	200
35	83	175	255	10.7	7–14	29,000	10,500	829	300
40	90	155	225	11.6	7–16	35,500	14,500	888	362
45	95	135	200	12.5	7–17	41,000	19,000	911	422
50	100	125	180	13.4	7–18	45,500	23,000	910	460
55	104	115	165	14.1	7–19	49,500	26,500	900	482
60	107	105	155	14.8	8–20	52,500	29,500	875	492
65	109	100	140	15.5	8–20	55,000	31,500	846	485
70	112	95	135	16.1	9–21	57,000	33,000	814	471
75	113	90	125	16.6	10–22	59,000	34,500	787	460
80	115	85	115	17.1	10–23	60,500	35,500	756	444

110-FOOT SITE

15	45	420	120	7.6	7	3,000		200	
20	59	300	260	8.3	7–10	10,000	1,000	500	50
25	70	235	295	9.4	7–12	18,500	4,500	740	180
30	81	190	275	10.4	7–14	27,500	9,000	917	300
35	91	160	240	11.5	7–15	36,000	14,500	1,029	414
40	99	140	210	12.5	7–17	43,000	20,000	1,075	500
45	105	125	185	13.5	7–18	49,500	25,000	1,100	556
50	110	115	165	14.4	8–19	54,500	29,500	1,090	590
55	114	105	150	15.1	8–20	59,000	33,500	1,073	609
60	118	100	140	15.9	9–21	63,000	36,500	1,050	608
65	120	95	125	16.6	10–22	66,000	38,500	1,015	592
70	122	90	120	17.3	10–23	68,000	40,500	971	579
75	124	85	110	17.9	11–23	70,000	42,000	933	560
80	126	80	105	18.4	11–24	71,500	43,500	894	544

120-FOOT SITE

15	49	390	155	7.7	7–8	4,600		307	
20	64	280	285	8.6	7–10	13,000	2,000	650	100
25	77	220	295	9.8	7–13	23,500	6,000	940	240
30	89	180	260	11.0	7–15	33,000	12,000	1,100	400
35	99	150	225	12.2	7–16	43,000	19,500	1,229	557
40	108	130	195	13.3	7–18	51,500	26,000	1,288	650
45	114	115	170	14.4	8–19	58,500	31,500	1,300	700
50	120	105	150	15.3	8–20	64,500	36,500	1,290	730
55	125	100	140	16.2	9–21	69,000	40,500	1,255	736
60	128	90	125	17.0	10–22	73,000	43,500	1,217	725
65	131	85	115	17.8	11–23	76,500	46,000	1,177	708
70	133	80	105	18.5	11–24	79,500	48,000	1,136	686
75	136	75	100	19.2	12–25	81,500	49,500	1,087	660
80	137	70	95	19.7	12–26	83,500	51,000	1,044	638

TABLE 19.—*Normal yield, in cords, second-growth longleaf pine*

Age (years)	Total height, average dominant tree	All trees		Merchantable trees			Yield per acre		Average yearly growth per acre	
		Stand per acre	D. b. h. of average tree	Stand per acre	Diameter		Rough wood	Peeled wood	Rough wood	Peeled wood
					Average	Range				
	Feet	*Number*	*Inches*	*Number*	*Inches*	*Inches*	*Cords*	*Cords*	*Cords*	*Cords*
40-FOOT SITE										
15	14	2,145	1.7	50	4.1					
20	20	1,550	2.4	215	4.4	4–4	1	1	0.05	0.05
25	25	1,220	2.9	265	4.6	4–5	3	2	.12	.08
30	30	990	3.4	300	4.9	4–6	5	4	.17	.13
35	33	810	3.8	330	5.1	4–6	7	5	.20	.14
40	36	690	4.2	345	5.3	4–7	9	6	.22	.15
45	38	615	4.5	360	5.5	4–7	10	7	.22	.16
50	40	560	4.8	360	5.7	4–7	11	8	.22	.16
55	42	510	5.1	355	5.9	4–8	12	9	.22	.16
60	44	470	5.4	345	6.1	4–8	13	10	.22	.17
65	45	440	5.7	335	6.3	4–9	14	11	.22	.17
70	47	410	5.9	325	6.5	4–9	15	12	.21	.17
75	48	385	6.1	315	6.7	4–9	16	12	.21	.16
80	49	365	6.4	300	6.9	4–10	17	13	.21	.16
50-FOOT SITE										
15	18	1,985	2.2	155	4.3	4–4	2	1	0.13	0.07
20	26	1,410	2.8	295	4.7	4–5	4	3	.20	.15
25	32	1,120	3.5	385	5.0	4–6	8	6	.32	.24
30	37	900	4.1	430	5.3	4–6	11	8	.37	.27
35	41	740	4.6	440	5.6	4–7	14	11	.40	.31
40	45	625	5.1	435	5.9	4–8	17	13	.42	.32
45	47	555	5.6	425	6.2	4–9	19	15	.42	.33
50	50	505	5.9	410	6.5	4–9	21	17	.42	.34
55	53	465	6.3	390	6.8	4–9	23	19	.42	.35
60	55	430	6.6	365	7.1	4–10	25	20	.42	.33
65	57	400	6.9	350	7.3	4–10	27	22	.42	.34
70	58	375	7.2	335	7.6	4–11	28	23	.40	.33
75	60	355	7.5	320	7.8	4–11	30	24	.40	.32
80	61	335	7.8	305	8.0	4–11	31	25	.39	.31
60-FOOT SITE										
15	22	1,800	2.5	205	4.4	4–5	5	3	0.33	0.20
20	31	1,290	3.3	400	5.0	4–6	8	6	.40	.30
25	38	1,020	4.2	500	5.4	4–7	14	10	.56	.40
30	44	815	4.9	540	5.8	4–8	19	14	.63	.47
35	49	670	5.5	550	6.2	4–8	24	18	.69	.51
40	53	575	6.0	475	6.6	4–9	27	21	.68	.52
45	57	515	6.5	440	7.0	4–10	31	25	.69	.56
50	60	465	7.0	410	7.3	4–10	34	28	.68	.56
55	63	425	7.4	385	7.7	4–11	37	30	.67	.55
60	65	395	7.8	360	8.0	4–11	40	33	.67	.55
65	68	365	8.1	340	8.4	4–12	43	35	.66	.54
70	70	345	8.5	320	8.7	4–12	45	37	.64	.53
75	72	320	8.8	305	9.0	4–13	47	39	.63	.52
80	73	305	9.1	290	9.3	4–13	49	40	.61	.50
70-FOOT SITE										
15	26	1,610	2.8	250	4.6	4–5	7	5	0.47	0.33
20	36	1,150	3.8	500	5.2	4–6	14	10	.70	.50
25	45	920	4.7	550	5.7	4–7	21	16	.84	.64
30	52	730	5.5	540	6.2	4–8	28	21	.93	.70
35	57	600	6.2	495	6.7	4–9	33	26	.94	.74
40	62	515	6.8	450	7.2	4–10	39	31	.98	.78
45	66	460	7.4	415	7.6	4–11	43	35	.96	.78
50	70	415	7.9	380	8.1	4–11	48	39	.96	.78
55	74	380	8.4	355	8.5	4–12	52	43	.95	.78
60	77	355	8.8	330	8.9	4–13	55	46	.92	.77
65	79	325	9.2	310	9.3	4–13	59	50	.91	.77
70	82	305	9.6	295	9.7	5–14	62	52	.89	.74
75	84	285	10.0	280	10.1	5–14	65	55	.87	.73
80	86	270	10.3	265	10.4	5–15	67	58	.84	.72

TABLE 19.—*Normal yield, in cords, second-growth longleaf pine*—Continued

80-FOOT SITE

Age (years)	Total height, average dominant tree	All trees		Merchantable trees			Yield per acre		Average yearly growth per acre	
		Stand per acre	D. b. h. of average tree	Stand per acre	Diameter		Rough wood	Peeled wood	Rough wood	Peeled wood
					Average	Range				
	Feet	*Number*	*Inches*	*Number*	*Inches*	*Inches*	*Cords*	*Cords*	*Cords*	*Cords*
15	30	1,450	3.2	300	5.1	4–5	11	8	0.73	0.53
20	41	1,050	4.3	580	5.5	4–7	20	15	1.00	.75
25	51	820	5.3	580	6.1	4–8	28	22	1.12	.88
30	59	655	6.1	530	6.7	4–9	36	28	1.20	.93
35	66	540	6.9	475	7.3	4–10	43	35	1.23	1.00
40	71	465	7.6	420	7.8	4–11	49	41	1.22	1.02
45	76	415	8.2	385	8.4	4–12	55	46	1.22	1.02
50	80	375	8.8	355	8.9	4–13	61	51	1.22	1.02
55	84	345	9.3	330	9.4	4–13	65	56	1.18	1.02
60	87	315	9.8	310	9.9	5–14	70	60	1.17	1.00
65	90	295	10.2	290	10.3	5–14	74	64	1.14	.98
70	93	270	10.6	270	10.8	5–15	78	68	1.11	.97
75	96	255	11.1	255	11.2	6–16	82	71	1.09	.95
80	98	240	11.5	240	11.6	6–16	85	74	1.06	.92
90-FOOT SITE										
15	33	1,260	3.5	345	5.3	4–6	16	12	1.07	0.80
20	46	910	4.7	580	5.7	4–7	26	20	1.30	1.00
25	57	720	5.9	550	6.4	4–9	35	27	1.40	1.08
30	66	575	6.7	495	7.1	4–10	43	35	1.43	1.17
35	74	465	7.6	425	7.8	4–11	51	42	1.46	1.20
40	80	405	8.3	380	8.4	4–12	59	49	1.48	1.22
45	85	365	9.0	345	9.0	4–13	66	56	1.47	1.24
50	90	330	9.6	320	9.6	5–14	72	61	1.44	1.24
55	94	300	10.2	295	10.2	5–14	78	68	1.42	1.24
60	98	275	10.7	275	10.7	5–15	84	73	1.40	1.22
65	102	255	11.2	255	11.2	6–16	89	78	1.37	1.20
70	105	240	11.6	240	11.7	6–16	94	83	1.34	1.19
75	108	220	12.1	225	12.2	6–17	99	87	1.32	1.16
80	110	210	12.5	215	12.6	7–17	103	90	1.29	1.12
100-FOOT SITE										
15	37	1,090	3.9	405	5.6	4–6	20	15	1.33	1.00
20	52	790	5.2	555	6.0	4–8	30	24	1.50	1.20
25	64	630	6.4	500	6.8	4–10	40	32	1.60	1.28
30	74	500	7.4	445	7.6	4–11	49	41	1.63	1.37
35	82	415	8.2	385	8.4	4–12	58	49	1.66	1.40
40	89	355	9.0	336	9.1	4–13	66	57	1.65	1.42
45	95	315	9.8	305	9.8	5–14	74	65	1.64	1.44
50	100	285	10.5	282	10.5	5–15	82	72	1.64	1.44
55	105	260	11.1	260	11.1	6–16	89	79	1.62	1.44
60	109	240	11.7	240	11.7	6–16	96	85	1.60	1.42
65	113	225	12.2	225	12.2	6–17	102	91	1.57	1.40
70	117	205	12.7	210	12.7	7–18	108	96	1.54	1.37
75	120	195	13.2	200	13.2	7–18	113	100	1.51	1.33
80	123	185	13.7	185	13.7	8–19	118	104	1.48	1.30
110-FOOT SITE										
15	41	960	4.2	420	5.7	4–7	22	16	1.47	1.07
20	57	690	5.6	520	6.3	4–9	34	26	1.70	1.30
25	70	550	6.9	465	7.2	4–10	44	36	1.76	1.44
30	81	445	7.9	405	8.1	4–11	54	45	1.80	1.50
35	90	365	8.9	350	9.0	4–13	64	54	1.83	1.54
40	98	315	9.8	309	9.8	5–14	73	63	1.82	1.58
45	104	275	10.7	275	10.6	5–15	82	71	1.82	1.58
50	110	250	11.4	250	11.4	6–16	90	79	1.80	1.58
55	115	230	12.1	230	12.1	6–17	98	87	1.78	1.58
60	120	210	12.7	210	12.8	7–18	106	94	1.77	1.57
65	124	195	13.3	195	13.3	7–18	113	100	1.74	1.54
70	128	180	13.8	180	13.9	8–19	119	105	1.70	1.50
75	132	170	14.4	170	14.4	8–20	125	110	1.67	1.47
80	135	160	14.9	160	14.8	8–20	130	115	1.62	1.44

TABLE 20.—*Normal yield, in board feet, second-growth longleaf pine*

40-FOOT SITE

Age (years)	Dominant trees		Trees 7 inches d. b. h. and larger			Yield per acre		Average yearly growth per acre	
	Total height, average tree	Stand per acre	Stand per acre	Diameter		International ¼-inch rule	Doyle rule	International ¼-inch rule	Doyle rule
				Average	Range				
	Feet	*Number*	*Number*	*Inches*	*Inches*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
15	14	730							
20	20	620		7.0					
25	25	500		7.2					
30	30	425	10	7.3					
35	33	370	22	7.4	7	500		14	
40	36	325	35	7.5	7	1,000		25	
45	38	295	50	7.6	7	1,000		22	
50	40	275	65	7.7	7	1,500		30	
55	42	255	84	7.8	7- 8	2,000		36	
60	44	240	105	7.9	7- 8	2,500		42	
65	45	225	116	8.0	7- 9	3,000		46	
70	47	215	125	8.1	7- 9	3,500	500	50	7
75	48	210	133	8.2	7- 9	4,000	500	53	7
80	49	195	140	8.3	7-10	4,500	500	56	6
85	50	190	145	8.4	7-10	5,000	500	59	6
90	51	185	150	8.5	7-10	5,000	1,000	56	11
95	51	180	153	8.6	7-10	5,500	1,000	58	11
100	52	175	155	8.6	7-11	6,000	1,500	60	15

50-FOOT SITE

15	18	685							
20	26	590		7.1					
25	32	480		7.3	7	500		20	
30	37	410	35	7.5	7	1,000		33	
35	41	355	61	7.6	7	1,500		43	
40	45	315	100	7.8	7- 8	2,500		62	
45	47	285	136	7.9	7- 9	3,500		78	
50	50	265	160	8.1	7- 9	5,000	500	100	10
55	53	250	175	8.3	7- 9	6,000	500	109	9
60	55	235	185	8.4	7-10	7,000	1,000	117	17
65	57	220	192	8.6	7-10	8,000	1,500	123	23
70	58	210	195	8.7	7-11	9,000	2,000	129	29
75	60	200	199	8.9	7-11	10,000	2,000	133	27
80	61	190	200	9.0	7-11	11,000	2,500	138	31
85	63	185	200	9.2	7-12	12,000	3,000	141	35
90	63	180	200	9.4	7-12	13,000	3,500	144	39
95	64	175	196	9.5	7-12	13,500	4,000	142	42
100	65	170	190	9.7	7-13	14,500	4,500	145	45

60-FOOT SITE

15	22	650							
20	31	560	15	7.3	7	500		25	
25	38	460	63	7.5	7	1,500		60	
30	44	390	110	7.7	7- 8	2,500		83	
35	49	340	148	7.9	7- 8	4,500		129	
40	53	305	185	8.1	7- 9	6,000	500	150	12
45	57	275	213	8.3	7-10	8,000	1,000	178	22
50	60	255	230	8.6	7-10	10,500	2,000	210	40
55	63	240	234	8.8	7-11	12,500	3,000	227	55
60	65	225	235	9.0	7-11	14,500	3,500	242	58
65	68	215	233	9.3	7-12	16,000	4,500	246	69
70	70	200	230	9.5	7-12	18,000	5,000	257	71
75	72	195	226	9.8	7-13	19,500	6,000	260	80
80	73	185	220	10.0	7-13	21,000	7,000	262	88
85	75	180	216	10.2	7-13	23,000	7,500	271	88
90	76	175	210	10.5	7-14	24,000	8,500	267	94
95	77	170	206	10.7	7-14	25,500	9,000	268	95
100	77	165	200	10.9	7-15	27,000	10,000	270	100

TABLE 20.—*Normal yield, in board feet, second-growth longleaf pine*—Continued

70-FOOT SITE

Age (years)	Dominant trees		Trees 7 inches d. b. h. and larger			Yield per acre		Average yearly growth per acre	
	Total height, average tree	Stand per acre	Stand per acre	Diameter		International ¼-inch rule	Doyle rule	International ¼-inch rule	Doyle rule
				Average	Range				
	Feet	*Number*	*Number*	*Inches*	*Inches*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
15	26	605	3	7.2	7	200	--------	13	--------
20	36	525	35	7.4	7	1,000	--------	50	--------
25	45	435	112	7.7	7	3,000	--------	120	--------
30	52	370	170	7.9	7–8	5,000	--------	167	--------
35	57	320	208	8.2	7–9	8,000	1,000	229	29
40	62	285	235	8.5	7–10	11,000	2,000	275	50
45	66	265	249	8.8	7–11	14,000	3,000	311	67
50	70	245	255	9.1	7–11	17,500	4,500	350	90
55	74	230	253	9.4	7–12	20,500	6,000	373	109
60	77	215	245	9.8	7–13	23,500	7,000	392	117
65	79	205	240	10.0	7–13	26,000	8,500	400	131
70	82	195	235	10.4	7–14	29,000	9,500	414	136
75	84	185	227	10.7	7–14	31,000	11,000	413	147
80	86	180	220	11.0	7–15	33,500	12,500	419	156
85	88	170	214	11.3	7–15	35,000	13,500	412	159
90	89	170	210	11.5	7–16	37,000	15,000	411	167
95	90	165	201	11.8	7–16	38,500	16,500	405	174
100	90	160	200	12.1	7–16	40,000	17,500	400	175

80-FOOT SITE

15	30	560	6	7.4	7	400	--------	27	--------
20	41	485	70	7.5	7	2,000	--------	100	--------
25	51	405	150	7.8	7–8	5,000	--------	200	--------
30	59	345	220	8.1	7–9	8,500	1,000	283	33
35	66	300	253	8.5	7–10	12,500	2,000	357	57
40	71	260	265	8.9	7–11	17,000	4,000	425	100
45	76	245	264	9.3	7–12	21,000	5,500	467	122
50	80	225	260	9.8	7–13	25,500	7,500	510	150
55	84	210	254	10.1	7–13	29,500	9,500	536	173
60	87	200	245	10.5	7–14	33,500	11,500	558	192
65	90	190	238	10.9	7–14	36,500	13,500	562	208
70	93	180	230	11.2	7–15	40,000	15,500	571	221
75	96	175	222	11.6	7–16	43,000	17,500	573	233
80	98	170	215	12.0	7–16	45,500	19,500	569	244
85	100	160	207	12.3	7–17	48,000	21,500	565	253
90	101	155	200	12.6	7–17	50,000	23,500	556	261
95	102	150	193	12.9	7–18	52,000	25,000	547	263
100	103	145	185	13.2	7–18	54,000	26,500	540	265

90-FOOT SITE

15	33	495	13	7.6	7	700	--------	47	--------
20	46	445	110	7.7	7	3,000	--------	150	--------
25	57	370	211	8.0	7–9	7,500	500	300	20
30	66	315	255	8.4	7–10	12,500	2,000	417	67
35	74	275	266	8.9	7–11	17,500	4,000	500	114
40	80	240	265	9.4	7–12	23,000	6,500	575	162
45	85	220	261	9.8	7–13	28,000	9,000	622	200
50	90	205	255	10.3	7–14	33,500	11,500	670	230
55	94	195	242	10.8	7–14	38,500	14,500	700	264
60	98	185	230	11.3	7–15	43,500	17,000	725	283
65	102	175	222	11.7	7–16	47,500	19,500	731	300
70	105	165	215	12.1	7–16	51,000	22,500	729	321
75	108	160	209	12.5	7–17	54,500	25,000	727	333
80	110	155	195	12.9	7–17	58,000	27,500	725	344
85	112	150	190	13.3	7–18	61,000	30,000	718	353
90	114	145	185	13.6	7–19	63,500	32,500	706	361
95	115	140	178	14.0	8–19	66,000	34,500	695	363
100	116	135	170	14.3	8–20	68,000	36,500	680	365

TABLE 20.—*Normal yield, in board feet, second-growth longleaf pine*—Continued

100-FOOT SITE

Age (years)	Dominant trees		Trees 7 inches d. b. h. and larger			Yield per acre		Average yearly growth per acre	
	Total height, average tree	Stand per acre	Stand per acre	Diameter		International ¼-inch rule	Doyle rule	International ¼-inch rule	Doyle rule
				Average	Range				
	Feet	*Number*	*Number*	*Inches*	*Inches*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
15	37	440	23	7.7	7	1,200		80	
20	52	400	140	7.8	7–8	5,000		250	
25	64	335	258	8.2	7–10	10,000	1,000	400	40
30	74	285	270	8.7	7–11	16,500	3,500	550	117
35	82	250	268	9.3	7–12	22,500	6,000	643	171
40	89	220	255	9.9	7–13	29,000	9,000	725	225
45	95	200	245	10.5	7–14	36,000	12,500	800	278
50	100	185	235	11.0	7–15	42,500	16,000	850	320
55	105	175	224	11.6	7–16	48,000	19,500	873	355
60	109	165	215	12.1	7–16	52,500	23,000	875	383
65	113	160	206	12.5	7–17	57,500	26,000	885	400
70	117	150	195	13.0	7–18	61,000	29,500	871	421
75	120	145	189	13.5	7–18	65,000	33,000	867	440
80	123	140	180	14.0	8–19	68,500	36,000	856	450
85	125	135	174	14.4	8–20	71,500	39,000	841	459
90	127	130	165	14.7	8–20	74,500	41,500	828	461
95	128	125	161	15.1	9–21	77,500	44,000	816	463
100	129	125	155	15.4	9–21	80,000	46,000	800	460
110-FOOT SITE									
15	41	390	31	7.8	7	1,700		113	
20	57	350	170	8.0	7–9	6,500		325	
25	70	300	273	8.5	7–10	12,500	2,000	500	80
30	81	255	275	9.1	7–11	19,500	5,000	650	167
35	90	220	257	9.8	7–13	26,500	8,000	757	229
40	98	195	240	10.5	7–14	35,000	12,000	875	300
45	104	175	230	11.2	7–15	42,000	16,000	933	356
50	110	165	220	11.8	7–16	49,000	20,500	980	410
55	115	155	209	12.4	7–17	55,000	24,500	1,000	445
60	120	145	200	13.1	7–18	60,500	29,000	1,008	483
65	124	140	189	13.5	7–18	65,000	32,000	1,000	492
70	128	135	180	14.0	8–19	69,000	36,500	986	521
75	132	130	170	14.5	8–20	72,500	40,000	967	533
80	135	125	160	15.0	8–20	76,000	43,500	950	544
85	137	120	153	15.4	9–21	80,000	46,500	941	547
90	139	115	145	15.8	9–22	83,000	49,000	922	544
95	140	110	137	16.2	10–22	86,000	51,000	905	537
100	142	110	130	16.6	10–23	89,000	53,000	890	530

TABLE 21.—*Normal yield, in cords, second-growth shortleaf pine*

40-FOOT SITE

Age (years)	Total height, average dominant tree	All trees		Merchantable trees			Yield per acre		Average yearly growth per acre	
		Stand per acre	D. b. h. of average tree	Stand per acre	Diameter		Rough wood	Peeled wood	Rough wood	Peeled wood
					Average	Range				
	Feet	*Number*	*Inches*	*Number*	*Inches*	*Inches*	*Cords*	*Cords*	*Cords*	*Cords*
15	15	11,300	1.3							
20	20	6,000	2.0	240	3.8					
25	24	3,405	2.7	540	4.2	4–5				
30	28	2,565	3.2	780	4.5	4–5	13	11	0.43	0.37
35	32	1,955	3.8	945	4.8	4–6	19	15	.54	.43
40	35	1,525	4.3	950	5.2	4–7	24	19	.60	.48
45	38	1,260	4.7	880	5.5	4–7	28	22	.62	.49
50	40	1,055	5.1	805	5.8	4–8	30	25	.60	.50
55	42	920	5.4	725	6.1	4–8	32	27	.58	.49
60	44	820	5.8	665	6.4	4–9	34	28	.57	.47
65	46	740	6.1	615	6.7	4–9	36	29	.55	.45
70	47	680	6.3	575	7.0	4–10	37	30	.53	.43
75	49	625	6.6	540	7.2	4–10	38	31	.51	.41
80	50	580	6.9	505	7.5	4–11	38	32	.48	.40

TABLE 21.—*Normal yield, in cords, second-growth shortleaf pine*—Continued

50-FOOT SITE

Age (years)	Total height, average dominant tree	All trees		Merchantable trees			Yield per acre		Average yearly growth per acre	
		Stand per acre	D. b. h. of average tree	Stand per acre	Diameter		Rough wood	Peeled wood	Rough wood	Peeled wood
					Average	Range				
	Feet	*Number*	*Inches*	*Number*	*Inches*	*Inches*	*Cords*	*Cords*	*Cords*	*Cords*
15	19	7,700	1.6	75	3.6					
20	25	3,425	2.5	440	4.1					
25	30	2,495	3.2	765	4.6	4–5	15	12	0.60	0.48
30	35	1,855	3.9	955	5.0	4–6	23	19	.77	.63
35	40	1,400	4.5	930	5.5	4–7	30	24	.86	.69
40	44	1,085	5.1	815	5.9	4–8	33	29	.82	.72
45	47	890	5.6	715	6.4	4–9	40	33	.89	.73
50	50	760	6.1	630	6.8	4–9	43	36	.86	.72
55	53	660	6.5	560	7.2	4–10	45	38	.82	.69
60	55	590	6.9	510	7.5	4–11	48	40	.80	.67
65	57	535	7.3	470	7.9	4–11	49	41	.75	.63
70	59	485	7.6	435	8.2	4–12	51	43	.73	.61
75	60	450	8.0	410	8.5	4–12	52	44	.69	.59
80	62	420	8.3	380	8.8	4–12	53	45	.66	.56

60-FOOT SITE

15	23	3,600	2.2	200	3.7					
20	30	2,520	2.9	530	4.3	4–5	12	10	0.60	0.50
25	36	1,905	3.8	920	4.9	4–6	23	18	.92	.72
30	42	1,370	4.6	955	5.5	4–7	32	26	1.07	.87
35	47	1,030	5.4	805	6.1	4–8	40	33	1.14	.94
40	52	815	6.0	680	6.6	4–9	46	38	1.15	.95
45	57	670	6.6	575	7.1	4–10	51	42	1.13	.93
50	60	570	7.2	505	7.6	4–11	54	46	1.08	.92
55	63	500	7.7	450	8.1	4–12	58	48	1.05	.87
60	66	445	8.2	410	8.5	4–12	60	51	1.00	.85
65	69	405	8.6	375	8.9	4–13	62	53	.95	.82
70	71	370	9.0	345	9.3	4–13	65	55	.93	.79
75	73	335	9.4	320	9.7	4–14	66	57	.88	.76
80	74	315	9.8	300	10.0	4–14	68	58	.85	.72

70-FOOT SITE

15	26	2,730	2.6	330	3.8					
20	34	1,965	3.5	780	4.6	4–6	18	15	0.90	0.75
25	42	1,480	4.5	900	5.3	4–7	31	25	1.24	1.00
30	49	1,060	5.4	825	6.0	4–8	41	34	1.37	1.13
35	55	780	6.2	660	6.7	4–10	49	41	1.40	1.17
40	61	625	7.0	545	7.4	4–11	56	47	1.40	1.18
45	66	515	7.7	460	8.0	4–12	61	52	1.36	1.16
50	70	440	8.3	405	8.6	4–12	66	56	1.32	1.12
55	74	385	8.9	360	9.1	4–13	70	60	1.27	1.09
60	77	345	9.4	330	9.7	4–14	73	63	1.22	1.05
65	80	315	9.9	300	10.1	5–14	76	65	1.17	1.00
70	82	285	10.4	280	10.6	5–15	79	68	1.13	.97
75	85	260	10.8	255	11.1	5–15	81	70	1.08	.93
80	86	240	11.2	235	11.5	6–16	83	71	1.04	.89

80-FOOT SITE

15	30	2,040	3.1	495	4.6	4–5	11	9	0.73	0.60
20	39	1,495	4.1	860	5.0	4–6	25	20	1.25	1.00
25	48	1,120	5.2	860	5.9	4–8	38	31	1.52	1.24
30	56	815	6.2	680	6.7	4–10	48	40	1.60	1.33
35	64	610	7.1	540	7.5	4–11	57	48	1.63	1.37
40	70	485	8.0	435	8.3	4–12	65	55	1.62	1.38
45	75	395	8.8	365	9.0	4–13	71	61	1.58	1.36
50	80	335	9.5	320	9.7	4–14	77	66	1.54	1.32
55	84	290	10.2	280	10.4	5–15	81	70	1.47	1.27
60	88	260	10.8	255	11.0	5–15	85	74	1.42	1.23
65	91	235	11.4	230	11.5	6–16	89	77	1.37	1.18
70	94	215	11.9	215	12.0	6–17	92	80	1.31	1.14
75	96	195	12.4	195	12.5	7–17	95	82	1.27	1.09
80	99	185	12.9	185	13.0	7–18	97	84	1.21	1.05

TABLE 21.—*Normal yield, in cords, second-growth shortleaf pine*—Continued

90-FOOT SITE

Age (years)	Total height, average dominant tree	All trees		Merchantable trees			Yield per acre		Average yearly growth per acre	
		Stand per acre	D. b. h. of average tree	Stand per acre	Diameter		Rough wood	Peeled wood	Rough wood	Peeled wood
					Average	Range				
	Feet	*Number*	*Inches*	*Number*	*Inches*	*Inches*	*Cords*	*Cords*	*Cords*	*Cords*
15	33	1,440	3.8	610	5.0	4– 6	15	12	1.00	0.80
20	44	1,080	5.0	800	5.8	4– 8	30	24	1.50	1.20
25	54	810	6.2	660	6.9	4–10	43	35	1.72	1.40
30	63	590	7.3	525	7.9	4–11	54	45	1.80	1.50
35	71	445	8.4	410	8.8	4–12	64	54	1.83	1.54
40	78	345	9.4	330	9.8	4–14	73	62	1.82	1.55
45	85	285	10.3	280	10.6	5–15	80	69	1.78	1.53
50	90	245	11.2	240	11.5	6–16	87	75	1.74	1.50
55	95	210	12.1	205	12.2	6–17	93	80	1.69	1.45
60	99	185	12.8	180	12.9	7–18	98	85	1.63	1.42
65	103	175	13.5	175	13.6	8–19	103	88	1.58	1.35
70	106	160	14.1	160	14.2	8–19	105	92	1.50	1.31
75	108	150	14.7	150	14.8	9–20	109	94	1.45	1.25
80	111	140	15.3	140	15.3	9–21	112	97	1.40	1.21
100-FOOT SITE										
15	37	970	4.6	605	5.6	4– 7	20	16	1.33	1.07
20	49	740	6.0	600	6.9	4– 9	33	27	1.65	1.35
25	60	550	7.4	480	8.2	4–11	47	40	1.88	1.60
30	70	405	8.8	370	9.5	4–13	60	51	2.00	1.70
35	79	300	10.1	290	10.6	5–15	72	62	2.06	1.77
40	87	235	11.3	230	11.7	6–16	82	71	2.05	1.78
45	94	190	12.5	190	12.7	7–17	91	79	2.02	1.76
50	100	170	13.5	165	13.6	8–19	99	86	1.98	1.72
55	105	145	14.5	145	14.5	8–20	106	92	1.93	1.67
60	110	130	15.3	130	15.4	9–21	111	97	1.85	1.62
65	114	120	16.1	115	16.2	10–22	116	101	1.78	1.55
70	117	110	17.0	105	17.0	-------	121	105	1.73	1.50
75	120	100	17.8	95	17.6	-------	124	108	1.65	1.44
80	123	90	18.5	90	18.5	-------	128	111	1.60	1.39

TABLE 22.—*Normal yield, in board feet, second-growth shortleaf pine*

40-FOOT SITE

Age (years)	Dominant trees		Trees 7 inches d. b. h. and larger			Yield per acre		Average yearly growth per acre	
	Total height average tree	Stand per acre	Stand per acre	Diameter		International ¼-inch rule	Doyle rule	International ¼-inch rule	Doyle rule
				Average	Range				
	Feet	*Number*	*Number*	*Inches*	*Inches*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
15	15	2,170	-------	-------	-------	-------	-------	-------	-------
20	20	1,690	-------	-------	-------	-------	-------	-------	-------
25	24	1,410	-------	-------	-------	-------	-------	-------	-------
30	28	1,105	5	7.0	-------	-------	-------	-------	-------
35	32	850	45	7.2	7	600	-------	17	-------
40	35	690	90	7.3	7	1,750	-------	44	-------
45	38	580	130	7.5	7	3,000	-------	67	-------
50	40	500	170	7.7	7– 8	4,300	-------	86	-------
55	42	440	200	7.8	7– 8	5,650	600	103	11
60	44	400	230	7.9	7– 9	6,900	950	115	16
65	46	365	250	8.1	7– 9	8,300	1,300	128	20
70	47	340	270	8.2	7–10	9,600	1,600	137	23
75	49	320	285	8.3	7–10	10,800	2,050	144	27
80	50	300	290	8.5	7–11	12,000	2,600	150	32
85	51	280	295	8.7	7–11	13,000	3,000	153	35
90	52	265	290	8.8	7–11	14,000	3,550	156	39
95	52	250	285	9.0	7–12	14,900	4,000	157	42
100	53	235	275	9.1	7–12	15,600	4,450	156	44

TABLE 22.—*Normal yield, in board feet, second-growth shortleaf pine*—Continued

50-FOOT SITE

Age (years)	Dominant trees		Trees 7 inches d. b. h. and larger			Yield per acre		Average yearly growth per acre	
	Total height average tree	Stand per acre	Stand per acre	Diameter		International ¼ inch rule	Doyle rule	International ¼-inch rule	Doyle rule
				Average	Range				
	Feet	*Number*	*Number*	*Inches*	*Inches*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
15	19	1,830							
20	25	1,395							
25	30	1,080	5	7.0					
30	35	815	50	7.2	7	900		30	
35	40	640	110	7.4	7	2,800		80	
40	44	520	175	7.7	7–8	5,000		125	
45	47	435	220	7.9	7–9	7,500	900	167	20
50	50	375	260	8.1	7–9	9,900	1,600	198	32
55	53	335	280	8.3	7–10	12,400	2,300	225	42
60	55	305	295	8.5	7–11	14,900	3,200	248	53
65	57	280	300	8.7	7–11	17,200	4,150	265	64
70	59	260	300	9.0	7–12	19,000	5,050	271	72
75	60	245	300	9.2	7–12	20,600	6,200	275	83
80	62	230	290	9.4	7–12	22,000	7,000	275	88
85	63	220	285	9.6	7–13	23,200	7,800	273	92
90	64	210	280	9.8	7–13	24,300	8,550	270	95
95	65	195	270	10.0	7–14	25,300	9,250	266	97
100	66	190	255	10.2	7–14	26,000	9,750	260	98

60-FOOT SITE

15	23	1,420							
20	30	1,065							
25	36	835	40	7.2	7	800		32	
30	42	625	120	7.5	7	3,300		110	
35	47	490	215	7.8	7–8	6,600	750	189	21
40	52	400	265	8.1	7–9	10,300	1,550	258	39
45	57	340	295	8.3	7–10	14,300	2,750	318	61
50	60	300	305	8.7	7–11	18,300	4,350	366	87
55	63	270	310	9.0	7–12	21,700	6,000	395	109
60	66	245	305	9.3	7–12	24,500	7,600	408	127
65	69	225	300	9.6	7–13	26,700	8,950	411	138
70	71	210	285	9.9	7–13	28,700	10,250	410	146
75	73	200	275	10.2	7–14	30,500	11,400	407	152
80	74	190	260	10.5	7–14	32,000	12,700	400	159
85	76	180	250	10.8	7–15	33,300	13,650	392	161
90	77	170	240	11.1	7–15	34,600	14,550	384	162
95	78	165	225	11.3	7–15	35,700	15,800	376	166
100	79	160	210	11.6	7–16	36,600	16,750	366	168

70-FOOT SITE

15	26	1,075							
20	34	850	20	7.1	7	250		12	
25	42	675	115	7.4	7	2,800		112	
30	49	505	225	7.8	7–8	6,900	750	230	25
35	55	390	295	8.2	7–10	12,000	2,000	343	57
40	61	320	315	8.6	7–11	17,800	4,000	445	100
45	66	275	320	9.0	7–12	23,000	6,400	511	142
50	70	245	305	9.4	7–12	27,200	8,650	544	173
55	74	220	295	9.8	7–13	30,700	10,800	558	196
60	77	200	280	10.2	7–14	33,500	12,600	558	210
65	80	190	265	10.6	7–14	36,000	14,450	554	222
70	82	175	250	11.0	7–15	38,200	16,250	546	232
75	85	165	230	11.3	7–15	40,200	17,900	536	239
80	86	160	220	11.7	7–16	42,000	19,400	525	242
85	88	150	205	12.0	7–16	43,700	20,850	514	245
90	90	145	195	12.4	7–17	45,200	22,300	502	248
95	91	140	185	12.7	7–17	46,500	23,700	489	249
100	93	135	180	13.0	7–18	47,800	25,050	478	250

TABLE 22.—*Normal yield, in board feet, second-growth shortleaf pine*—Continued

80-FOOT SITE

Age (years)	Dominant trees		Trees 7 inches d. b. h. and larger			Yield per acre		Average yearly growth per acre	
	Total height average tree	Stand per acre	Stand per acre	Diameter		International ¼-inch rule	Doyle rule	International ¼-inch rule	Doyle rule
				Average	Range				
	Feet	*Number*	*Number*	*Inches*	*Inches*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
15	30	825							
20	39	665	70	7.3	7	1,600		80	
25	48	535	195	7.7	7– 8	5,700	500	228	20
30	56	410	300	8.2	7–10	11,800	1,950	393	65
35	64	325	320	8.7	7–11	18,800	4,300	537	123
40	70	265	315	9.2	7–12	25,500	7,650	638	191
45	75	225	295	9.8	7–13	30,900	10,700	687	238
50	80	200	275	10.4	7–14	35,600	13,550	712	271
55	84	180	250	10.9	7–15	39,300	16,350	715	297
60	88	165	235	11.3	7–15	42,600	18,850	710	314
65	91	150	220	11.8	7–16	45,400	21,300	698	328
70	94	145	205	12.3	7–17	47,900	23,450	684	335
75	96	140	190	12.7	7–17	50,100	25,550	668	341
80	99	135	180	13.2	7–18	52,000	27,550	650	344
85	101	130	170	13.6	7–18	53,800	29,400	633	346
90	103	125	160	14.0	8–19	55,500	31,000	617	344
95	104	120	150	14.4	8–20	57,100	32,650	601	344
100	106	115	145	14.8	9–20	58,500	34,000	585	340

90-FOOT SITE

15	33	630	20	7.5	7	200		13	
20	44	500	150	7.6	7– 8	3,800		190	
25	54	400	290	8.2	7–10	10,700	1,750	428	70
30	63	310	325	8.8	7–11	18,900	4,550	630	152
35	71	250	305	9.5	7–12	27,000	8,650	771	247
40	78	205	280	10.3	7–14	33,400	12,600	835	315
45	85	175	245	11.0	7–15	39,200	16,450	871	366
50	90	160	220	11.7	7–16	44,250	20,450	885	409
55	95	145	200	12.4	7–17	48,500	24,200	882	440
60	99	135	175	13.1	7–18	52,250	27,400	871	457
65	103	130	170	13.7	8–19	55,300	30,300	851	466
70	106	125	155	14.2	8–19	58,100	32,850	830	469
75	108	120	145	14.8	9–20	60,600	35,150	808	469
80	111	115	135	15.4	9–21	62,800	37,400	785	468
85	113	105	130	15.9	10–22	65,000	39,400	765	464
90	115	100	120	16.4		66,800	40,950	742	455
95	117	90	110	16.9		68,600	42,400	722	446
100	119	90	105	17.4		70,100	43,650	701	436

100-FOOT SITE

15	37	450	65	7.8	7	1,400		93	
20	49	355	245	8.1	7– 9	7,600	1,150	380	58
25	60	290	325	8.9	7–11	16,800	4,250	672	170
30	70	230	305	9.8	7–13	26,200	9,050	873	302
35	79	190	255	10.8	7–15	34,700	14,150	991	404
40	87	155	215	11.8	7–16	41,800	19,400	1,045	485
45	94	135	185	12.7	7–17	48,200	24,750	1,071	550
50	100	125	160	13.7	8–19	53,800	29,500	1,076	590
55	105	115	140	14.6	8–20	58,400	33,850	1,062	615
60	110	105	130	15.4	9–21	62,500	37,250	1,042	621
65	114	100	120	16.1	10–22	66,300	40,300	1,020	620
70	117	95	110	16.9		69,500	42,950	993	614
75	120	85	100	17.6		72,300	45,250	964	603
80	123	75	90	18.3		74,800	47,200	935	590
85	126	70	80	19.0		76,800	48,950	904	576
90	128	65	75	19.6		78,800	50,500	876	561
95	131	60	70	20.2		80,300	51,650	845	544
100	133	60	70	20.8		81,600	52,750	816	528

TABLE 23.—*Normal yield, in cords, second-growth slash pine*

60-FOOT SITE

Age (years)	Total height, average dominant tree	All trees		Merchantable trees			Yield per acre		Average yearly growth per acre	
		Stand per acre	D.b.h. of average tree	Stand per acre	Diameter		Rough wood	Peeled wood	Rough wood	Peeled wood
					Average	Range				
	Feet	*Number*	*Inches*	*Number*	*Inches*	*Inches*	*Cords*	*Cords*	*Cords*	*Cords*
15	29	2,620	3.0	475	4.3	4–5	12	9	0.80	0.60
20	36	2,035	3.5	835	4.7	4–6	20	14	1.00	.70
25	42	1,545	4.3	925	5.2	4–7	26	18	1.04	.72
30	48	1,140	5.0	810	5.7	4–8	32	23	1.07	.77
35	52	870	5.7	700	6.2	4–9	36	27	1.03	.77
40	55	710	6.3	615	6.7	4–9	40	30	1.00	.75
45	58	615	6.8	550	7.1	4–10	43	32	.96	.71
50	60	550	7.2	505	7.5	4–11	45	34	.90	.68
55	62	500	7.6	470	7.8	4–11	47	36	.85	.65
60	64	470	7.9	445	8.1	4–11	48	37	.80	.62
70-FOOT SITE										
15	34	1,855	3.6	700	4.8	4–6	21	14	1.40	0.93
20	42	1,445	4.2	840	5.1	4–7	28	20	1.40	1.00
25	49	1,110	5.1	805	5.8	4–8	34	25	1.36	1.00
30	56	820	6.0	685	6.4	4–9	40	30	1.33	1.00
35	61	615	6.8	555	7.1	4–10	46	35	1.31	1.00
40	64	500	7.5	475	7.7	4–11	49	38	1.22	.95
45	67	435	8.1	420	8.3	4–12	53	41	1.18	.91
50	70	390	8.6	375	8.8	4–12	55	43	1.10	.86
55	72	360	9.0	343	9.1	5–13	57	45	1.04	.82
60	74	335	9.4	325	9.4	5–13	59	47	.98	.78
80-FOOT SITE										
15	39	1,390	4.1	710	5.2	4–6	27	19	1.80	1.27
20	48	1,090	4.9	765	5.6	4–8	35	25	1.75	1.25
25	56	825	5.9	675	6.4	4–9	42	31	1.68	1.24
30	63	610	7.0	555	7.2	4–10	48	37	1.60	1.23
35	69	460	7.9	440	8.0	4–11	54	42	1.54	1.20
40	73	380	8.7	370	8.8	4–12	58	45	1.45	1.12
45	77	330	9.4	325	9.5	5–13	62	49	1.38	1.09
50	80	295	10.0	290	10.0	5–14	65	51	1.30	1.02
55	83	270	10.4	270	10.4	6–14	67	54	1.22	.98
60	85	250	10.8	250	10.8	6–15	69	56	1.15	.93
90-FOOT SITE										
15	43	1,065	4.8	685	5.6	4–7	32	24	2.13	1.60
20	54	835	5.6	665	6.1	4–9	41	30	2.05	1.50
25	63	635	6.8	570	7.1	4–10	48	37	1.92	1.48
30	71	470	8.0	450	8.2	4–12	54	42	1.80	1.40
35	77	355	9.1	350	9.2	5–13	60	48	1.71	1.37
40	83	295	10.0	290	10.1	5–14	66	52	1.65	1.30
45	87	250	10.8	250	10.8	6–15	70	56	1.56	1.24
50	90	220	11.4	220	11.4	7–15	73	59	1.46	1.18
55	93	205	12.0	205	12.0	7–16	76	61	1.38	1.11
60	95	195	12.5	195	12.5	8–16	78	63	1.30	1.05
100-FOOT SITE										
15	48	835	5.5	610	6.1	4–8	37	28	2.47	1.87
20	61	625	6.4	545	6.8	4–10	46	35	2.30	1.75
25	71	495	7.8	470	8.0	4–11	53	41	2.12	1.64
30	79	365	9.1	355	9.2	5–13	59	47	1.97	1.57
35	86	270	10.3	270	10.3	6–14	66	53	1.89	1.51
40	92	225	11.4	225	11.4	7–15	72	58	1.80	1.45
45	96	195	12.3	195	12.3	8–16	77	62	1.71	1.38
50	100	175	13.1	175	13.1	9–17	81	66	1.62	1.32
55	103	160	13.7	160	13.7	9–18	84	68	1.53	1.24
60	106	150	14.2	150	14.2	10–18	86	71	1.43	1.18

TABLE 24.—*Normal yield, in board-feet, second-growth slash pine*

60-FOOT SITE

Age (years)	Dominant trees		Trees 7 inches d. b. h. and larger			Yield per acre		Average yearly growth per acre	
	Total height, average tree	Stand per acre	Stand per acre	Diameter		International ¼-inch rule	Doyle rule	International ¼-inch rule	Doyle rule
				Average	Range				
	Feet	*Number*	*Number*	*Inches*	*Inches*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
15	29	1,050							
20	36	865	40	7.1	7	500		25	
25	42	685	110	7.3	7	2,000		80	
30	48	530	175	7.6	7–8	4,000		133	
35	52	420	245	7.9	7–9	6,000		171	
40	55	350	275	8.2	7–9	8,500	500	212	12
45	58	315	295	8.4	7–10	11,000	1,500	244	33
50	60	285	305	8.6	7–11	13,000	2,000	260	40
55	62	265	315	8.8	7–11	14,500	3,000	264	55
60	64	255	320	9.0	7–11	16,000	3,500	267	58

70-FOOT SITE

15	34	780	25	7.1	7	700		47	
20	42	640	85	7.3	7	2,000		100	
25	49	510	190	7.6	7–8	4,500		180	
30	56	400	275	8.0	7–9	8,000	500	267	17
35	61	315	295	8.4	7–10	11,500	1,500	329	43
40	64	265	305	8.8	7–11	15,000	2,500	375	62
45	67	235	305	9.1	7–12	18,000	4,000	400	89
50	70	220	300	9.4	7–12	20,500	5,500	410	110
55	72	205	295	9.7	7–13	22,500	6,500	409	118
60	74	195	285	10.0	7–13	24,000	7,500	400	125

80-FOOT SITE

15	39	605	55	7.2	7	1,500		100	
20	48	500	150	7.5	7–8	4,000		200	
25	56	400	265	7.9	7–9	8,000		320	
30	63	310	305	8.4	7–10	13,000	1,500	433	50
35	69	250	305	8.9	7–11	17,500	3,500	500	100
40	73	210	295	9.5	7–12	22,000	6,000	550	150
45	77	190	280	10.0	7–13	25,500	8,000	567	178
50	80	175	260	10.4	7–14	28,000	10,000	560	200
55	83	160	245	10.8	7–14	30,500	11,500	555	209
60	85	155	230	11.1	7–15	32,000	12,500	533	208

90-FOOT SITE

15	43	475	95	7.4	7	3,100		207	
20	54	400	220	7.8	7–9	6,500		325	
25	63	320	305	8.4	7–10	13,000	1,500	520	60
30	71	250	325	9.1	7–12	18,500	4,000	617	133
35	77	205	295	9.8	7–13	24,000	7,000	686	200
40	83	175	260	10.5	7–14	28,500	10,000	712	250
45	87	155	230	11.1	7–15	32,000	12,500	711	278
50	90	140	210	11.6	7–15	35,000	15,000	700	300
55	93	130	195	12.1	7–16	37,500	16,500	682	300
60	95	125	185	12.6	8–16	39,500	18,000	658	300

100-FOOT SITE

15	48	385	115	7.6	7–8	5,400		360	
20	61	320	255	8.2	7–10	10,500	1,000	525	50
25	71	255	330	8.9	7–11	17,500	3,500	700	140
30	79	205	300	9.8	7–13	24,000	7,000	800	233
35	86	165	240	10.8	7–14	29,500	11,000	843	314
40	92	140	210	11.6	7–15	34,500	14,500	862	362
45	96	125	185	12.4	8–16	38,500	17,500	856	389
50	100	115	170	13.1	9–17	41,000	19,500	820	390
55	103	110	160	13.7	9–18	43,500	21,500	791	391
60	106	105	150	14.2	10–18	45,500	23,000	758	383

STAND TABLES

EXPLANATION OF TABLES

A single figure, such as the diameter of the average tree above a specified diameter (columns 4 and 6 of the cordwood-yield tables, and column 5 of the board-foot-yield tables), gives a misleading idea of the size of the trees in a stand. Even the range of diameters, which is given in other columns of the same tables, does not give a complete picture. Hence the desirability of stand tables, which have been earlier defined as tables showing the number of trees of each diameter class that occur in a given stand. Two forms of such tables are presented here.

AVERAGE-SITE STAND TABLES

Tables 26, 27, 28, and 29 show the number of trees at and above various diameters which are to be found on a normally stocked acre of each species of pine on its average site, at 5-year intervals from 15 years up.

The average site is not necessarily the precise average for the species over its large natural range, but is the average of those stands which were actually measured in the course of the study. Since the field crews worked in many States and made no effort whatever to select certain sites more than others, but tried to get a fair sample of all of the territory visited, it is reasonable to assume that the average stand they measured is the actual average for the species, as it occurs in second growth to-day.

Some of the column headings require definition. D. b. h., average tree, is the diameter breast high of the average of all trees 1.6 inches in diameter (the lower limit of the 2-inch class) and up. The number of trees in the 2-inch column means the number of trees at and above 1.6 inches; those in the 4-inch column the trees at and above 3.6 inches; and so on. If the number of 2 and 3 inch trees alone is wanted, the figure in the 4-inch column is subtracted from the figure for the same age of stand in the 2-inch column; and the number of trees in any other 2-inch class is similarly obtained. For reasons which will be explained later the figures are not given for every inch class.

PERCENTAGE STAND TABLE

The foregoing tables, although very simple and therefore easy to use, apply only to the average site for each species. Table 30 presents similar information in the form of percentages for each species in a fully stocked stand on any site and at any age. For this calculation it is only necessary to obtain from the cordwood-yield tables the number of trees 1.6 inches in diameter or larger in the stand, and the diameter of the average tree among them (columns 3 and 4, respectively, of Tables 17, 19, 21, and 23).

It has been discovered in the course of the present study (4) that in normal or fully stocked stands of southern pine there is a quite regular and even percentage distribution of diameters both above and below the average diameter. That is, if in a fully stocked stand, regardless of site or age, the average tree has a diameter of 10 inches, about half of the trees are below 10 inches in diameter and about half above; furthermore, there will be a fixed percentage of the total number of trees an inch below this average and the same percentage an

inch above; a fixed percentage 2 inches below the average and the same percentage 2 inches above; and so on throughout the range of diameters in the stand. These percentages vary with the average diameter of the stand and are expressed cumulatively as in the average-site stand tables.

The column headings are explained as in the average-site stand tables, but in the present instance the figures in the main body of the table are percentages and not actual numbers. In order to obtain the numbers of trees at and above various diameters in any stand, the total number of trees in the stand must be multiplied by the percentages in the table. Suppose, for example, the stand tables are to be used in determining the number of trees 2 inches and larger, 4 inches and larger, etc., in a 30-year-old stand of loblolly on a 100-foot site. From column 4, Table 17, 100-foot site class, it appears that the diameter of the average of all trees in this stand is 9 inches, and from column 3 of the same table that the number of trees is 375. Table 30 shows that in a 9-inch stand 100 per cent of the trees, or 375 in this case, are 2-inches or larger; 97 per cent, or 364, are 4 inches or larger; 13 per cent, or 49, are 12 inches or larger. Those at or above other limits are similarly obtained by multiplication. The values in Table 26 were derived in this way.

APPLICATION OF THE STAND TABLES

The foregoing paragraph suggests the chief use of the stand tables—at least an approximate calculation of the yield of special products obtainable only from trees of certain sizes, such as lumber of particular dimensions, or poles, piling, and the like. This and two minor uses are described below.

CALCULATION OF THE YIELD FROM TREES OF CERTAIN SIZES

Suppose it is desired to know the number of board feet, by the International rule, contained in trees 12 inches in diameter and larger in a fully stocked loblolly stand on the average site at 40 years. According to Table 26, an acre of such timber has 77 trees 12 inches in diameter or larger; 28 trees, 14 inches or larger; 7 trees, 16 inches or larger; and one 18 inches or larger. Then, by subtraction, the number of 12-inch trees is 49; of 14-inch, 21; of 16-inch, 6; and of 18-inch, 1. Since (col. 3, Table 18) there are 170 dominant trees on this site at 40 years (considering it as an even 90-foot site) the 77 largest are undoubtedly dominant. Their heights are certain to be at least that of the average dominant, which in column 2 of the same table is given as 81 feet. From the volume table for diameter and total height (Table 6) the volumes of these trees in board feet by the International rule may be obtained, either by using the figures for 80-foot trees or more accurately—to allow for the extra foot above 80—by using volumes greater than these by one-tenth of the difference between 80-foot and 90-foot trees. The total volume in trees between 12 and 18 inches, thus calculated, is about 14,100 board feet. This should be conservative for several reasons; the average site was rounded off from 92 to 90 feet in the computation, the trees considered would undoubtedly have heights somewhat greater than the average dominants, and a considerable proportion of the trees in each 2-inch class are larger than the size used to designate the class

(the twenty-one "14-inch" trees include some of 15 inches for example).

Table 30 permits of a similar calculation for stands of any other average diameter, regardless of site. Since the breast-high diameters of the average tree above 1.6 inches, on which the application of the percentage stand tables is based, are presented only in the cordwood tables and since the cordwood tables for longleaf and shortleaf pines, as here given, do not extend above 80 years, the diameter figures are supplemented by those in Table 25.

TABLE 25.—*Breast-high diameters of average trees, 85–100 years, longleaf and shortleaf pines*

Site	Longleaf pine diameters at age stated				Shortleaf pine diameters at age stated			
	85 years	90 years	95 years	100 years	85 years	90 years	96 years	100 years
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
40-foot	6.6	6.8	7.0	7.2	7.1	7.4	7.6	7.8
50-foot	8.0	8.3	8.6	8.8	8.6	8.9	9.2	9.4
60-foot	9.4	9.8	10.1	10.3	10.1	10.4	10.8	11.1
70-foot	10.7	11.0	11.3	11.7	11.6	12.0	12.4	12.8
80-foot	11.9	12.3	12.6	13.0	13.4	13.8	14.3	14.7
90-foot	13.0	13.4	13.8	14.2	15.9	16.4	16.9	17.4
100-foot	14.2	14.6	15.0	15.4	19.2	19.9	20.6	21.2
110-foot	15.4	15.8	16.3	16.7				

The number of poles, piles, dock shores, or other large material obtainable from a stand of given age on a particular site may obviously be determined from the stand table. Caution is, however, necessary because these products are classified by their diameters at the upper end, whereas the stand tables are based on diameters near the lower end (breast height). There is much variation in the taper of individual trees. It is therefore unsafe to assume, for example, because an average tree 14 inches in diameter will furnish a pole of specified upper diameter and length that a normal stand containing fifty 14-inch trees, according to the stand table, will cut out 50 such poles. Some of the trees, because of rapid taper, will fail to furnish a pole. When material of a large range of sizes is acceptable, however, and when, therefore, a tree which just fails to make a pole or other product of one class may be credited to the next smaller class of nearly the same value, the stand tables may be used more confidently.

CALCULATION OF THE EARLIEST AGE AT WHICH SPECIAL PRODUCTS ARE MATURED

If the problem is to determine how early in the life of a stand special products obtainable only from trees of a specified size will be produced, stand tables may be used. At what age, for example, are hewn loblolly ties first produced in paying quantities on an average site? For standard ties trees from 12 to 15 inches in diameter are best. According to Table 26, 31 trees of these diameters are produced in normal stands at 30 years, and few before that age. For tram ties 10-inch trees will do, of which about 53 trees of this size or slightly larger are produced at 25 years.

For other than an average site Table 30 (again using loblolly pine as an illustration) is used in this problem. From this table it will be

seen that in order to contain more than 1 per cent of standard-tie trees (12 inches in diameter and over) a stand must average at least 8 inches in diameter. Then column 4, Table 17, shows that on a 60-foot site such trees do not appear in the stand until it is past 50 years old, on a 90-foot site until it is nearly 30 years old, and so on.

STAND TABLES AS A GUIDE IN THINNING

The stand tables, like the yield tables, are likely to prove of increasing value as a guide in thinning. This is particularly true where the French method of thinning, or "thinning from above," is employed. The essence of this method is to select at the time of thinning a small number of desirable trees which will make up the final stand of whatever product is desired and to thin the surrounding stand to benefit these. If the object of the landowner is to raise trees of a specified size in paying quantities as early as possible in the life of the stand, he may form some idea from the stand tables of the number of trees of the size which are normally developed at any given age on the site in question and gradually thin his stand to not more than that number. The effect will be to shorten the period of time necessary to bring them to the required size.

LIMITATIONS OF THE STAND TABLES

The stand tables should be used only in connection with stands that are normal. In fully stocked stands the uniform distribution of trees above and below the average in size appears to hold remarkably well, but very wide variations may be expected in stands which are not normal. Those which are overcrowded will undoubtedly contain more trees below the average in diameter than above; that is, a small number of large trees will be associated with a large number of small ones. In open or understocked stands the situation will be reversed, and a few trees will be found of larger diameter than any in a normal stand. Such variations as these make any attempt to apply the tables to other than normal stands very dangerous. Even in normal stands the use of 1-inch classes is not justified by the accuracy which may be expected of the figures.

TABLE 26.—*Stand table for second-growth loblolly pine, normal stand, average site* [1]

Age (years)	Average diameter, breast high	Number of trees per acre at and above d. b. h. of—											
		2 inches	4 inches	6 inches	8 inches	10 inches	12 inches	14 inches	16 inches	18 inches	20 inches	22 inches	24 inches
	Inches												
15	4.3	1,175	693	188	15								
20	5.7	770	616	331	92	11							
25	7.1	530	482	360	180	53	8						
30	8.4	410	390	332	221	102	31	6					
35	9.5	335	325	298	231	137	60	17	3				
40	10.4	285	279	262	219	148	77	28	7	1			
45	11.3	245	243	233	206	157	96	44	15	3			
50	12.2	215	213	209	191	155	108	56	24	6	1		
55	12.9	190	188	184	175	148	108	65	28	10	3		
60	13.6		175	172	164	145	116	74	38	16	5	1	
65	14.3		155	153	149	135	112	78	43	20	7	2	
70	14.9		145	144	141	130	110	81	49	25	10	3	
75	15.4		135	134	132	124	108	82	54	28	12	4	1
80	15.9			130	127	122	108	86	58	32	14	5	2

[1] Site index 92 feet.

TABLE 27.—*Stand table for second-growth longleaf pine, normal stand, average site* [1]

Age (years)	Average diameter, breast high	Number of trees per acre at and above d. b. h. of —									
		2 inches	4 inches	6 inches	8 inches	10 inches	12 inches	14 inches	16 inches	18 inches	20 inches
	Inches										
15	2.8	1,595	383	37							
20	3.8	1,140	513	114	10						
25	4.8	910	582	228	38	3					
30	5.6	720	556	303	87	13					
35	6.3	595	499	321	119	25	3				
40	6.9	510	454	326	153	42	7				
45	7.5	455	420	333	187	68	14	2			
50	8.0	410	386	321	201	82	21	3			
55	8.5	375	361	308	211	102	31	6			
60	8.9	350	337	298	214	112	39	8	1		
65	9.3	320	312	283	216	122	48	13	2		
70	9.7	300	296	275	217	136	60	18	4		
75	10.1	280	276	262	220	147	73	25	6		
80	10.4	265	264	248	211	147	77	29	8	1	
85	10.8	250	249	239	209	154	86	35	10	2	
90	11.1	240	240	232	206	157	94	41	13	3	
95	11.4	230	230	223	200	158	97	46	16	4	
100	11.8	220	220	215	198	160	107	56	21	6	1

[1] Site index 71 feet.

TABLE 28.—*Stand table for second-growth shortleaf pine, normal stand, average site* [1]

Age (years)	Average diameter, breast high	Number of trees per acre at and above d. b. h. of —									
		2 inches	4 inches	6 inches	8 inches	10 inches	12 inches	14 inches	16 inches	18 inches	20 inches
	Inches										
15	2.6	2,775	499								
20	3.5	1,993	877	100	2						
25	4.5	1,500	1,006	330	38	1					
30	5.4	1,075	850	441	118	13					
35	6.2	790	681	451	182	40	5				
40	7.0	635	571	425	222	76	15	1			
45	7.6	525	481	387	235	99	26	4			
50	8.2	445	419	357	241	116	36	8			
55	8.8	390	375	328	242	133	51	13	2		
60	9.3	350	340	304	238	144	63	18	4		
65	9.8	320	310	288	234	150	74	26	6		
70	10.3	290	283	266	225	156	84	35	9	2	
75	10.7	265	261	248	214	158	90	37	11	2	
80	11.1	245	242	232	205	159	95	44	15	3	
85	11.5	230	226	219	198	157	100	50	18	5	
90	11.9	215	211	207	190	153	104	55	21	6	1
95	12.3	200	196	192	180	152	109	61	26	8	2
100	12.7		188	184	175	150	113	68	30	11	3

[1] Site index 69.5 feet.

TABLE 29.—*Stand table for second-growth slash pine, normal stand, average site* [1]

Age (years)	Average diameter, breast high	Number of trees per acre at and above d. b. h. of—							
		2 inches	4 inches	6 inches	8 inches	10 inches	12 inches	14 inches	16 inches
	Inches								
15	4.2	1,360	816	218	19				
20	5.0	1,065	788	341	64	4			
25	6.0	805	692	427	153	24	2		
30	7.1	595	553	422	220	65	11		
35	8.0	450	432	364	234	90	22	3	
40	8.8	370	363	326	237	118	37	7	
45	9.5	320	317	298	237	138	54	13	2
50	10.1	290	287	276	235	154	70	19	3
55	10.6		265	257	228	162	82	26	5
60	11.0		245	240	218	162	88	32	6

[1] Site index 81 feet.

TABLE 30.—*Stand table for second-growth southern pines, normal stands, all sites*

LOBLOLLY PINE

D. b. h. of average tree in stand (inches)	Percentage of all trees at and above d. b. h. of—												
	2 inches	4 inches	6 inches	8 inches	10 inches	12 inches	14 inches	16 inches	18 inches	20 inches	22 inches	24 inches	26 inches
4	100	52	10	1									
5	100	72	29	5									
6	100	83	49	16	2								
7	100	90	66	32	9	1							
8	100	94	78	49	20	5	1						
9	100	97	86	63	34	13	3						
10	100	98	91	74	47	23	7	2					
11	100	99	94	82	60	34	15	4	1				
12	100	99	96	88	70	47	24	9	3	1			
13		100	98	92	79	59	35	16	6	2			
14		100	99	95	85	68	46	25	11	4	1		
15		100	99	97	91	78	58	36	18	7	2	1	
16			100	98	94	84	68	46	26	12	4	1	
17			100	99	96	89	76	56	36	19	8	3	1
18			100	99	98	93	83	67	46	28	13	5	2

LONGLEAF PINE

3	100	28	3										
4	100	49	13	1									
5	100	67	28	6									
6	100	81	49	17	3								
7	100	90	66	32	9	2							
8	100	94	78	49	20	5	1						
9	100	97	86	63	34	12	3						
10	100	98	92	76	49	24	8	2					
11	100	99	95	84	63	37	16	5	1				
12	100	99	97	90	74	50	26	10	3	1			
13			98	93	81	62	38	18	7	2			
14			99	96	88	72	51	29	13	4	1		

SHORTLEAF PINE

4	100	55	11										
5	100	74	32	7									
6	100	85	53	20	4								
7	100	90	67	35	12	2							
8	100	94	78	51	23	7	1						
9	100	96	86	64	36	14	4	1					
10	100	98	91	75	50	25	9	2					
11	100	99	95	83	62	37	16	5	1				
12	100	99	97	90	74	50	27	11	3	1			
13		100	98	94	82	62	38	19	7	2			
14		100	99	96	88	72	51	28	12	4	1		
15			100	98	93	82	63	40	21	8	3	1	
16			100	99	96	88	73	52	31	15	5	2	

SLASH PINE

3	100	28	2										
4	100	56	13	1									
5	100	74	32	6									
6	100	86	53	19	3								
7	100	92	69	35	10	1							
8	100	96	81	52	20	5	1						
9	100	98	89	66	35	12	2						
10	100	99	95	80	51	22	6	1					
11		100	98	89	66	36	13	3					
12		100	99	94	79	52	22	6	1				
13			100	98	89	68	36	13	3				

SUMMARY

Timber growing is one of the three great uses, and the most immediate one, of over 102,000,000 acres of cut-over pineland. The utilization of the original forest growth of this land brought wealth and prosperity into many portions of the South, but where the land was rendered idle in the process it has become a heavy burden on the owners and the community alike. Reforestation of former pinelands is generally simple and easy, provided fire is kept out. Other obstacles, such as unjust taxation, may be overcome. In spite of every obstacle, a few landowners, both large and small, are already deliberately growing timber in the South.

Timber growing is the only means of eventually checking the decline in the pine industries of the South, which at present employ 20 per cent of all those engaged in all manufacturing enterprises, represent about a quarter of the capital investment in all manufactures of the region, and have an output valued at more than $524,000,000 yearly. Second growth, in spite of the comparatively low-quality timber which it now produces, appears capable of filling every demand of the future for forest products.

The very extensive use of southern pine lumber and other products in the North and Middle West and the effect which their withdrawal from competition, already under way, will have on prices of forest products generally indicate the national importance of southern pine.

Under these conditions the rate at which the southern pines grow becomes a matter not only of vital local importance but of national importance also. Without knowledge of this rate, relatively few of the great number of southern pine landowners will undertake to grow more timber. Hence the significance of the figures presented in the latter part of this circular.

APPENDIX

METHODS EMPLOYED IN THE GROWTH STUDY

The methods used in both field and office during these studies of volume and yield are described elsewhere (*4*, *5*). For items of only technical value, such as average deviations from the volume and yield tables, the reader is referred to a more technical publication of the United States Department of Agriculture (*15*) giving fuller details of the study.

SOLID CONTENTS OF STACKED CORDS

Table 31 is based on the measurement of 117 second-growth loblolly pines of various diameters. These trees were cut into 4-foot lengths, and the wood from trees of different diameters was stacked separately. The stem above a 1-foot stump was used to a top diameter, inside the bark, of 3 inches, but no limb wood was included. When the same wood was later peeled and restacked for measurement, it revealed no consistent difference between peeled and unpeeled wood in the air space to the stacked cord. It is probable that the amount of solid wood to the cord found in this study is about the maximum, since more than ordinary care was used in the stacking. Because the cord is at best an extremely rough unit, varying greatly with the care used in limbing the wood and in stacking, the values for loblolly pine may be used with reasonable accuracy for the other pines as well.

TABLE 31.—*Solid contents of a stacked cord of 4-foot wood obtained from trees of different diameters*

Diameter, breast high	Contents of cord	Diameter, breast high	Contents of cord	Diameter, breast high	Contents of cord
Inches	*Cubic feet*	*Inches*	*Cubic feet*	*Inches*	*Cubic feet*
4	84	9	95	14	98
5	88	10	96	15	98
6	90	11	97	16	98
7	92	12	97	17	98
8	94	13	97	18	98

THE INTERNATIONAL LOG RULE

The derivation of the International rule has been described (*9*) as follows:

This log rule is the result of investigations by Judson F. Clark. It is designed for use with a band saw, cutting a saw kerf of one-eighth inch. The principles underlying the derivation of the rule are as follows:

(1) A ⅛-inch allowance is made for saw kerf, and a 1/16-inch allowance for shrinkage and unevenness in sawing.

(2) The minimum board is 3 inches in width, containing not less than 2 board feet. A 3-inch board must, then, be at least 8 feet long to be included; a 4-inch board, 6 feet long; a 5-inch board, 5 feet long; a 6-inch board, 4 feet long.

(3) An allowance is made for a ½-inch taper for each 4 feet of length. Professor Clark has shown that this is a conservative allowance for merchantable logs of all species so far studied in this country, including white pine, loblolly pine, spruce, balsam fir, chestnut, and northern hardwoods.

(4) Provision is made for the loss due to normal crook and that due to human and mechanical imperfections. By normal crook is meant the average crook of first-class logs accepted at the average mill. The average crook allowed in the rule is about 1.5 inches, and does not exceed 4 inches in 12 feet. Any crook more than 4 inches would have to be specially discounted by the scaler. Professor Clark first estimated this loss theoretically and then proved his computations by extensive tests at the mill. His studies showed that the waste due to crooks and surface imperfections is, like the waste in square edging, directly proportional to the diameter of the log.

The necessary allowance for waste in edging, crooks, etc., was determined by mathematical computations and by tests at the mill. With these principles established, the log table was compiled by first computing the contents of logs 4 feet long and then of logs of other lengths, allowing a taper of 1 inch in 8 feet.

Table 32 presents the International rule as designed for a one-eighth inch saw kerf. For a one-quarter inch saw kerf the deduction from the table values is a flat 9.5 per cent.

TABLE 32.—*International log rule (saw kerf one-eighth inch)*

Diameter of log, inches	Length of log, feet						
	8	10	12	14	16	18	20
	Volume in board feet						
5	5	5	10	10	15	15	20
6	10	10	15	20	20	25	30
7	15	15	20	25	30	35	45
8	20	25	30	35	45	50	60
9	25	30	40	50	55	65	75
10	30	40	50	60	70	85	95
11	40	50	65	75	90	105	115
12	50	65	75	90	105	125	140
13	60	75	90	110	130	145	165
14	70	90	110	130	150	175	195
15	80	105	125	150	175	200	225
16	95	120	145	170	200	230	260
17	105	135	165	195	225	260	295
18	120	155	185	220	255	295	330
19	135	175	210	250	290	330	370
20	150	195	235	275	320	365	410
21	170	215	260	305	355	405	455
22	185	235	285	340	390	445	500
23	205	260	315	370	430	490	550
24	225	285	345	405	470	535	600
25	245	310	375	445	510	580	650
26	265	335	405	480	555	630	705
27	290	365	440	520	600	680	765
28	310	395	475	560	645	735	825
29	335	425	510	605	695	790	885
30	360	455	550	645	745	845	950
31	385	485	590	695	800	905	1,015
32	410	520	630	740	850	965	1,080
33	440	555	670	790	905	1,030	1,150
34	470	590	715	840	965	1,095	1,225
35	495	625	755	890	1,025	1,160	1,300
36	525	665	800	945	1,085	1,230	1,375

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U. S. GOVERNMENT PRINTING OFFICE: 1930